The Journal of ENGINEERING EDUCATION

February 1, 1958 *Table of Contents* Vol. 48, No. 5

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TEACHING POSITIONS AVAILABLE

ASSISTANT OR ASSOCIATE PROfessor—To teach undergraduate courses in Aeronautical Engineering and graduate courses in propulsion, instrumentation, or structures. Industrial and teaching experience desired. Opportunities available for further graduate study, consulting, and research. Send resume of education and experience to: Chairman, Department of Aeronautical Engineering, Wayne State University, Detroit 2, Michigan.

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INSTRUCTORS OF CIVIL ENGIneering to teach courses in Engineering Drawing, Descriptive Geometry and Surveying. February and September 1958. Opportunity for graduate work and research. Good promotion policy. Excellent opportunity for development. Write F. A. Biberstein, Head, Department of Civil Engineering, The Catholic University of America, Washington 17, D. C.

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(*Continued on page 412*)

DO YOU KNOW . . . .

► . . . . That in about two weeks you will be receiving the 1958 Yearbook and Membership Directory? According to the new publication schedule of the JOURNAL it has a February 15 publication date. So, remember that there now are two February issues of the JOURNAL! The Yearbook will contain the statistics on enrollment and degrees granted, and the annual audit, as well as the usual Society records. The continued effort to improve the listings of members is bearing fruit. The alphabetical listing contains 8012 names whereas the membership file contains 8028. That isn't bad, but it also isn't perfect. Since the material went to press we found one of the 16 known errors. If any of you find others, please inform the Secretary's office.

► . . . . That the statistics for the article on enrollment and degrees granted in *all* of the colleges having one or more curricula accredited by ECPD are gathered in about one month's time, tabulated and analyzed in about six weeks, and printed in about another six? That is the schedule required for getting them in the Yearbook. Dr. H. H. Armsby and his associates; did a very fine job, they and the registrars submitting the information deserve a special "Thank you." There can be no laggards in such a tight schedule and deans are requested to "pass on" the thanks. To whet your appetite, the changes in the number of B.S., M.S., and Ph.D. degrees granted as compared to 1956, are + 18.5%, + 11%, and − 2%, respectively; the 1957 enrollments for the same degrees are + 7%, + 11%, and + 23%, respectively.

► . . . . That there are 58 living members of the Society who have been members since 1910 or earlier? That means they have been members at least 47 years! The two "longest time members" are W. F. Durand of Stanford University and James Fisher of Michigan College of Mining and Technology. There truly is a tie for the honor, for both were elected at the same meeting, August 17, 1899. Congratulations to both—and may they set a precedent for many, many more to follow.

► . . . . That the Society has the following publications for sale for 25¢ each? (1) "Engineering and Scientific Manpower Problems—An Annotated Bibliography" is divided into two major areas, engineering education and general engineering and scientific manpower. Under the former heading are 76 references under the sub-headings of engineering faculty shortage, faculty salaries, engineering teaching, engineering curricula, and miscellaneous. Under the second major heading are 161 references under the sub-headings of engineering manpower shortage, proposed solutions to shortage, salaries and income, recruitment and training, manpower utilization, general statistics, and miscellaneous. It is interesting to note that 48, or about 20 per cent of all the references come from the *Journal of Engineering Education!* (2) "Salaries and Earnings of Engineering Teachers—1956" is, in effect, a supplement to the EJC report on "Professional Income of Engineers—1956." The survey schedules used by EJC were turned over to the CDEF for more extensive analysis. Results are in terms of the arithmetic mean, and data are presented by faculty rank, number of years in the profession, and geographic area. Replies from 4081 engineers in

the teaching profession are the basis for the study.

► . . . . That the YET representatives of the schools in the North-Midwest Section had a meeting to discuss their activities? The minutes of the meeting indicate that some interesting topics were discussed. It was agreed that a YET Section meeting be held in conjunction with the regular Section Meeting at the University of Wisconsin in October, 1958. The theme of the meeting will be "The Engineering Teacher—His First Five Years of Professional Development."

► . . . . That the New England Section has suggested for their annual meeting at Harvard in October, 1958, that the YET group plan a program for selected senior and graduate students who are interested in teaching as a career? Each school is to assume the cost of its student representatives. This sounds like a fine idea and it is hoped other Sections give thought to developing programs having similar objectives.

► . . . . That ECPD and EJC are proposing to develop a five-year program of joint meetings? Two meetings a year in geographically different areas of the country is the plan being considered.

► . . . . That a bibliography on educational television (ETV) is in existence? Copies of "A Selected Bibliography on Educational Television" may be obtained from the Educational Television and Radio Center, 2320 Washtenaw Avenue, Ann Arbor, Michigan.

► . . . . That "Conquest" is a two-year, ten-production major public service television program? It will bring to the public modern science's most outstanding advances in a factual, understandable, and entertaining manner as formulated by the scientists themselves. The program is sponsored by Monsanto Chemical Company and presented by CBS in cooperation with the AAAS and the NAS.

► . . . . That the U. S. Office of Education has undertaken a study of faculty staffing? Several years will be required for completion, but the study is divided into several phases for prompt reporting. Because salary studies already have been made, nothing will be done in that area except to compare subject matter fields.

► . . . . That nearly seven per cent or 142,000 of the two million Federal employees in 1953–54 were engaged in the conduct of research and development and related activities? This is reported in "Scientific Manpower in the Federal Government, 1954," published by the National Science Foundation. Of the 142,000 total, 37,000 were scientists and engineers; the remainder were supporting personnel. Another 65,000 scientists and engineers were employed in construction and operations work, giving a grand total of 102,000. Two per cent, or 77,000, of all military personnel were also engaged in scientific activities, about 9000 of whom were scientists and engineers; the remainder were supporting personnel.

W. Leighton Collins
Secretary

The University of California at Berkeley

SCENE OF THE 66th ANNUAL MEETING OF ASEE

June 16 to 20, 1958

WAYNE H. SNOWDEN

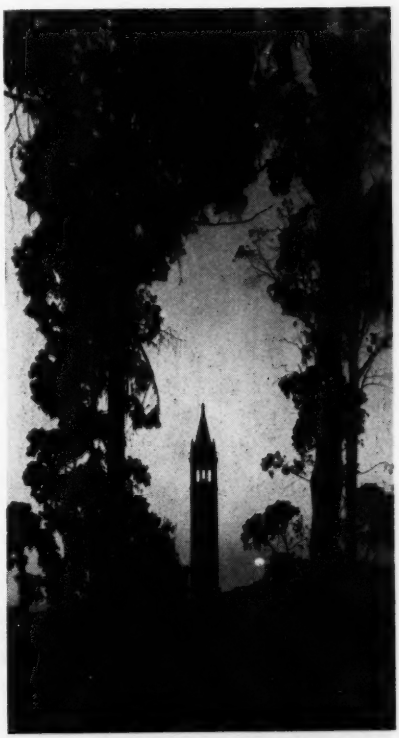
Lecturer, Transportation Engineering
University of California, Berkeley

ASEE members from all parts of the country will gather in Berkeley, California next June for the 66th Annual Meeting. Here, in the center of one of the most beautiful and variegated regions of the United States, an almost unlimited variety of attractions lie close at hand. It would indeed be a satiated traveller who did not find inspiration or diversion in the fabled environs of San Francisco Bay.

San Francisco, the City, needs no introduction. Its shops, its night life, its Opera House where the United Nations came into being, its art galleries, its Chinatown, its Golden Gate Park—these *are* San Francisco to people all over the world.

Berkeley, a city of 114,000, is across the Bay from San Francisco, half an hour away. From Berkeley one looks west across the Bay to San Francisco, the Golden Gate, and the rolling California hills. A center of intellectual and artistic activity in its own right, Berkeley is also the home of the oldest of the University of California's eight campuses.

The Berkeley campus lies at the base of the East Bay hills, marked by its 307-foot Campanile, which can be seen for miles around. The Campanile stands in the center of grounds covering anywhere from roughly 600 to 1000 acres, depending on how one counts. The photograph at left shows the campus proper, on a gentle slope reaching to the hills, which provide a backdrop for the university. The 81,000-seat memorial stadium can be seen, as well as the open, classically monumental Greek Theater, and the many buildings of the University's



The Berkeley Campanile, as seen looking west toward San Francisco Bay from the eastern edge of the campus near Founder's Rock.

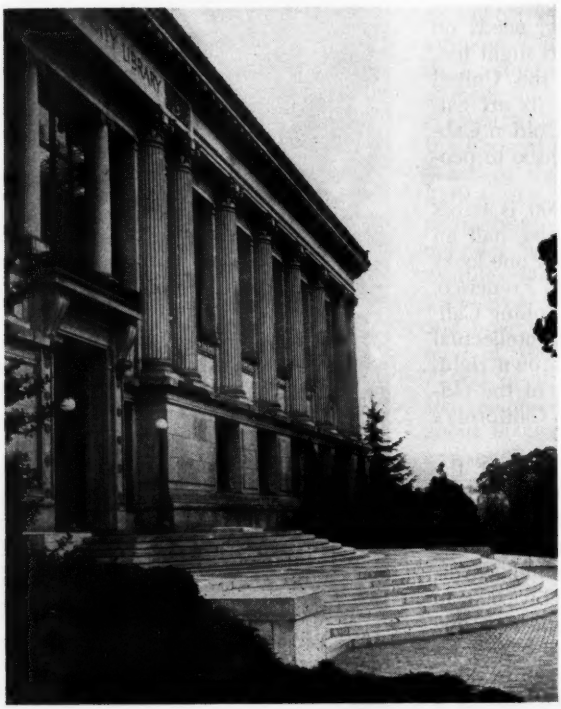
world famous Radiation Laboratory (upper left).

The hills also have their landmark: a huge block "C", normally golden, but traditionally changing color. The change is not by seasons, but according to the relative enthusiasm of its sophomore guardians and of U. C. freshmen and invaders from other schools.

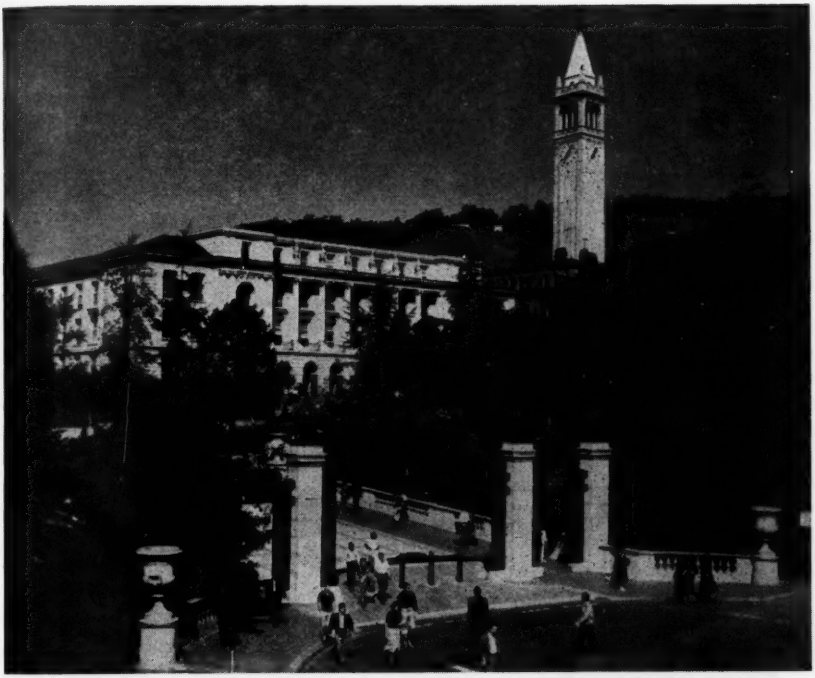
Returning to the campus proper, the visitor will perhaps be most struck by the park-like atmosphere, maintained despite tremendous expansion of building facilities. Over the past two decades, Berkeley has served enrollments of from 13,000 to more than 23,000, and the prospect of even larger student bodies lies ahead.

It is hard to say what a visitor to a university such as this would most want to see, especially a vistor from another college. ASEE members will naturally have major interest in engineering facilities, and these will require discussion in a separate article. Aside from them, however, the visitor will want at least to walk inside the spacious University Library, containing more than two million volumes and generally regarded as one of the three foremost university libraries of the country in quality of scholarly works. From the library it is just a step to the Campanile, where an elevator lifts visitors to a magnificent view of the entire Bay Area. Other places near the top of the visitor's "want to see" list would surely be the Greek Theater already mentioned, and the International House, world-famous living center for foreign students.

Whatever his itinerary, the ASEE



The central building of the Berkeley campus is the Charles Franklin Doe Memorial Library, which contains one of the largest collections in the country. A general reference room extends all along the front of the building from the base of the columns to the high, vaulted ceilings. Numerous research, reading, and seminar rooms are in constant use by students and faculty. Facing the Library is Wheeler Hall, which houses classrooms, faculty offices, and an auditorium where special drama, lectures, and music events are held. To the Southeast is famous old South Hall, only remaining building of the original campus.



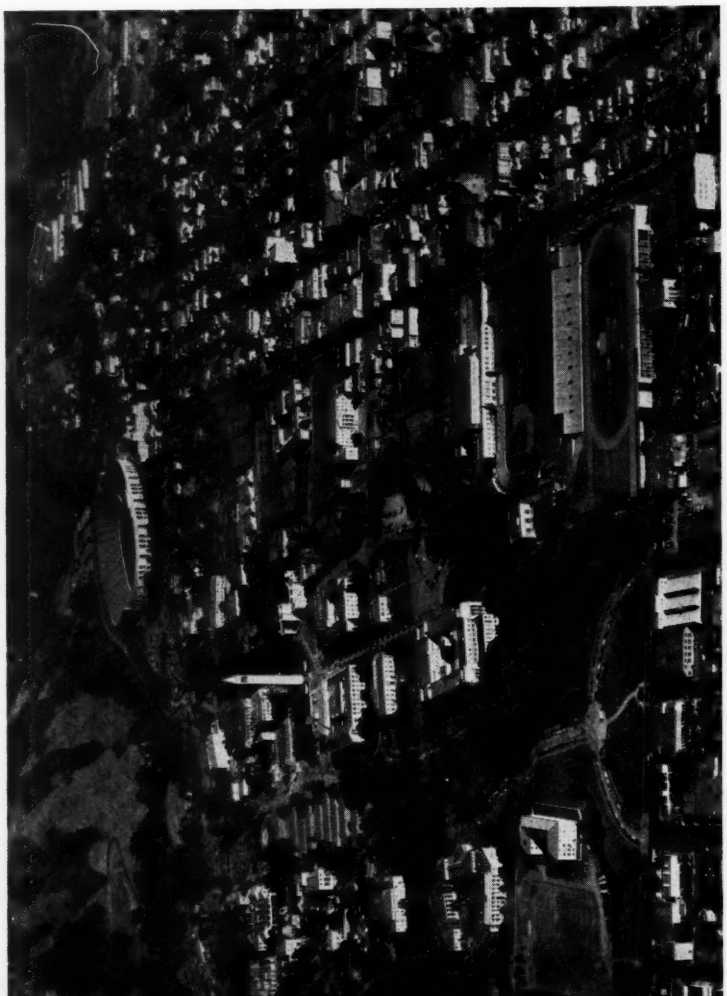
One of the most famous landmarks of the Berkeley campus is Sather Gate, given to the University in 1908 to honor one of the original trustees. In the background is Wheeler Hall, a major classroom building for the College of Letters and Science.

guest may feel more at home seeing what he chooses to see, if he can view it against its historical setting. The University now consists of eight campuses, scattered throughout the State. But in the beginning, the University and the Berkeley campus were one.

The University of California was chartered by the State in 1868 (but it lists its first graduates as Class of 1964, because it acquired the assets of a pre-existing college at the time of chartering). At that time it was situated in Oakland, adjacent to Berkeley, and still the largest city in the East Bay, but in 1873 the University was moved to Berkeley.

In that same year, the second campus, now known as the San Francisco Medical Center, was established across the Bay in San Francisco. Others followed in this order: Lick Observatory, Mt. Hamilton, 1888; Davis, emphasizing agriculture and home economics, 1905; Riverside, liberal arts college and citrus experiment station, 1905; La Jolla, pronounced la hoya, the Scripps Institute of Oceanography, 1912; Los Angeles, 1919; and Santa Barbara College, specializing in the liberal arts, 1944. Berkeley and Los Angeles now each comprise the many colleges, schools, and departments that are normally associated with the term university. The other campuses, as indicated, are more specialized. The total enrollment on all campuses is presently more than 40,000.

The vistor at Berkeley is thus on



The University of California at Berkeley.

The University of California at Berkeley.

the oldest and largest of the eight campuses that make the University of California one of the two or three greatest in the world. Enrollment is presently almost 19,000 (it was higher after World War II), and is expected to reach a planned maximum of 25,000 within 10 years.

It is difficult to describe the quality or character of a university, and universities are understandably reluctant to attempt it. But the faculty is often cited as the essence of a university, and some matters of record may therefore be cited concerning the faculty at the University of California. With six Nobel Prize winners, the faculty ranks first nationally in number of members awarded Guggenheim Fellowships and second in membership in the National Academy of Sciences. Also, according to the American Council on Education, the University ranks second in the number of distinguished departments maintained.

Research activities on the eight campuses amount to $150,000,000 a year. Much of this work is supported, wholly or in part, by state, Federal, and private agencies. Of the vast new contributions to knowledge that have grown out of this work, perhaps the easiest to single out—at least in the physical sciences—is the synthesis, at Berkeley, of elements 93 through 101, including Plutonium (94) and Berkelium (97), together with the identification of the antiproton and the antineutron.

This research emphasis, and a corresponding emphasis on graduate instruction, are part of a broad policy which distinguishes between the main purposes of the University's eight campuses, and the purposes of a separate system of state colleges and junior colleges. The latter play an important part in the over-all educational system in California and several offer curricula in engineering. There are, in addition, a large number of private colleges and universities. Most noteworthy of the private institutions in the San Francisco Bay area are Stanford University, the University of Santa Clara, the University of San Francisco, and St. Mary's College.

Speaking again of the University of California, ASEE meeting time will occur toward the close of a period in which the University has been under the leadership of President Robert Gordon Sproul. His presidency has extended over more than a quarter-century, a period that has seen the University grow to its present position of eminence and distinction. Clark Kerr, presently the Chancellor of the Berkeley Campus, has been named to succeed President Sproul, and will take office July 1.

At the outset, some mention was made of a few of the many things to do in the metropolitan area immediately surrounding Berkeley. The occasional visitor to the far west will, however, undoubtedly want to roam a little farther. Just an hour away, across the Golden Gate Bridge, he can visit a grove of California's coast redwoods (*Sequoia sempervirens*). A three-hour trip south along the scenic coast line will take him to Monterey Bay, Monterey, and Carmel, which still are reminiscent of California's Spanish beginnings and offer fine examples of the famous Missions. Five hours' travel to the east from Berkeley will take him to the Sierra Nevadas, to ghost towns of the gold country, to Yosemite alley, and to groves of Sequoia redwoods (*Sequoia gigantea*).

And. . . . But this is a bare suggestion of chapter headings for a proper guide to California, its University, and Berkeley. The thing to do is see for yourself, in June.

Our Opportunity and Our Responsibility . . . .

TEACHER RECRUITMENT IS *OUR* PROBLEM

An urgent statement from the Committee on the Development of Engineering Faculties

We engineering professors individually are now, this month, face to face with such a clear and unique responsibility and opportunity as rarely appears. Recruitment of future faculty from our present seniors is a critical need. There is no personnel man to do this job; *we* are the ones who must do it.

We all know the facts in general terms, but let's look at them closely. The American baby crop really started up sharply about 1940, just about 18 years ago. The rise in birth rate continued for six to eight years and remains at a high level. The first of these increasing numbers of young people are just beginning to knock on our college doors for admission. Furthermore, a larger fraction of them than ever before are knocking. To add to this bounty, world events spectacularly shine the spotlight on science and engineering, creating an unprecedented public awareness of their importance. Here is the opportunity for our colleges of engineering, ready-made, indeed forced upon us, far beyond our fondest professional hopes. But with it is a great responsibility of very sobering proportions. Given money, we can build and equip buildings rapidly, but faculty can only be grown, slowly, deliberately, and carefully.

The President's Committee on Education Beyond the High School is very clear on the college faculty recruitment problem, saying,* "The need for recruitment is a national problem, but its accomplishment depends heavily upon each faculty. There are no better recruiters for any profession than its own members. The teacher is uniquely able to identify talented young people and to encourage them to direct their studies toward a teaching career."

The start of growth as a teacher and of the attraction of teaching as a career takes place primarily in the residential graduate school. The real key to solving the vital engineering faculty problem, therefore, is to encourage our ablest seniors to go on to graduate school. Each of us, as individual engineering professors, holds this key in his hand. Each must use it, promptly, wisely, intelligently. Our responsibility for doing so falls little short of a national call to duty in today's world.

Exercising this responsibility wisely and well places some rather

* Second Report to the President, July 1957, p. 29. No thoughtful professor can afford to miss this report which his president and dean have undoubtedly studied in detail. (For sale by Superintendent of Documents, U. S. Gov. Printing Office, Washington 25, D. C. Price 55 cents.)

severe demands on us. Graduate school and a possible teaching career become attractive to our finest students only when this career is clearly identified with some of our highest professional ideals. Many of us are articulate only with effort and much forethought when discussing these ideals. We all know the struggle necessary to gain deep insight and understanding of even a straightforward explicit physical concept in preparation for facing a class of bright students. We must be at least as well prepared for discussing the values associated with further education and with a teaching career.

Let's not sell short by talking of three-months holidays, of tenure safety, of a not-too-strenuous life. Let us rather look at the opportunity for professional achievement in a field of our own choosing; for becoming a recognized authority in that field; for the stimulation and challenge of working with eager young minds, some better than our own but needing guidance and inspiration; for upholding with our colleagues the ideals and intellectual values of the university as a community of students, scholars, and investigators; and for a life of rigorous activity motivated not so much from external pressures as from the inner drive to learn and to share this learning.

On the material side, which can never be ignored, teaching has in recent decades been pushed back seriously by inflation. But the frankness and objectivity with which this fact has entered public consciousness, and the seriousness of its implications for education in a world situation rapidly shaping up as a mortal competition in quality education, make prospects ahead for teachers better than for many years past. Teachers also will find a seller's market during the next decade when the law of supply and demand will work favorably and probably vigorously.

The challenge to us is clear. The country must now have many more engineering teachers. We, individually, and we alone can do the basic recruiting. We must tell our ablest students about teaching—clearly, thoughtfully, honestly. We must encourage and assist our best seniors to enter residential graduate study as an essential step toward a distinguished teaching career. The nation's future may well depend upon how well and how wisely each of us responds to this challenge.

H. L. Hazen
December 27, 1957

MANPOWER REQUIREMENTS FOR A UNIVERSITY RESEARCH REACTOR

HENRY J. GOMBERG
Professor of Nuclear and Electrical Engineering
ARDATH H. EMMONS
Assistant Dean, College of Engineering
University of Michigan, Ann Arbor

This paper, presented at the June, 1957, meeting of ASEE at Cornell University, describes the Ford Nuclear Reactor Staff which now operates a one-megawatt educational reactor at the University of Michigan.

In 1951, the University of Michigan began to explore, with the Atomic Energy Commission Committee on Reactor Safeguards, the possibility of building a one-megawatt reactor for teaching and research. It was to be built in the center of a rapidly developing campus area so that students and faculty would have easy access to it. The location was selected for general utility and to help prevent the development of the "private empire" concept which often follows isolation of major installations.

The initial reaction of many members of the safeguards committee was, to say the least, cold. In their minds, the concept of a moderately powerful reactor which would be readily accessible and possibly operated by people as irresponsible as college students and as undisciplined as college professors was not pleasing.

On the other hand, it was apparent that if the field were to grow and develop properly, university groups must enter the field. As was pointed out, the safest reactor is no reactor at all, but this logic is hardly acceptable.

Since that initial conference, the differences have been resolved. The reactor has been built on the site originally selected and went into operation in September, 1957.

The brief history cited above is given not to be critical of any group, but rather to emphasize the conflicting concepts which must be reconciled if education and research in nuclear technology are to develop as have other fields of science.

Out of the conflicting needs for safety and reliability, on the one hand, and use of the reactor in teaching, with student participation through course-work and research, there has developed a sound operational philosophy. A major aspect of this philosophy is reflected in the organization of the staff.

Operational Philosophy

A reactor properly built and operated can be extremely safe, yet still be useful. But a reactor mishandled is a very potent source of danger. To help meet this problem, policy decisions and long-range programming for the reactor have been separated from responsibility for day-to-day scheduling and operational supervision. Maintenance and repair are separated from experiment design and preparation of research equipment.

The very important responsibility for enforcing the observance of safety regulations has been placed in the hands, first, of the health physics staff within the laboratory, and secondly, a safety supervisor responsible to an

autonomous university-wide committee operating directly under top University Administration. Figure 1 shows the staff organization.

The staff is large enough to see that the reactor is in proper condition to produce the radiation required, or to illustrate a specific principle. In a teaching experiment, however, responsibility for research planning and execution remains with the teaching and research staff. These workers must set up their own equipment, take their own data, and carry out their own clean-up.

Universities cannot afford, nor should they indulge in, large or special staffs which do all the work and carry all the responsibility. On the other hand, a one-megawatt reactor is too large to handle on a completely casual basis, through exploitation of the "spare" time of faculty, and through coercion of students.

What Staff Needed?

In response to the question of how many men are really needed, the following organizational plan evolved. The assembling of a staff for a one-megawatt teaching and research reactor could be preceded by the assignment of five members of the teaching staff to an advisory committee. These people would not be members of the laboratory or reactor service staff, but would serve in the capacity of a competent review board. It is suggested that the membership be made up of a physicist, a chemical engineer, a mechanical engineer, and a chemist, together with a nuclear engineer. This advisory committee would work with the operational staff of the reactor laboratory.

Direction and Supervision

The first man on the operational staff is the laboratory director. He is charged with supervision of the total reactor facility, including experimental laboratories associated with the reactor. His presence is not required for routine operation; therefore, he is available for teaching duties on a half-time basis.

The second man is a reactor supervisor charged with the direct supervision of the reactor. His duties include such things as the scheduling of all experiments for the reactor, the billing of all charges for the use of the reactor, preparation of operational budgets, service as a member of the advisory committee, maintenance of records and, of primary importance, the operational integrity of the reactor. The supervisor is available to all research people on the campus as an advisor on applications of the reactor to specific research problems and to teaching.

For depth in case of emergency and for staff training, it was desirable to have an associate reactor supervisor. He is charged with the responsibility of knowing the supervisors's job. The associate is in a position to see that a daily operating schedule is followed, releasing the reactor supervisor for part-time teaching duties. During routine operation, with the supervisor present on the premises, the associate supervisor takes care of such matters as the assignment of personnel to various research facilities, the supervision of electronic and mechanical maintenance work, and the control of routine daily operations.

The reactor supervisor and his associate have the basic responsibility of operating the reactor in a safe, reliable, efficient, and economical manner. Further, they are responsible for accommodating all experimenters to the fullest extent permitted by staff, budget, schedule, and policy. Their duties include the instruction of personnel, publication of a reactor operational schedule, personal supervision

of nonroutine reactor operation, and establishment of improved operating methods for routine experiments.

It is essential that the reactor supervisor and his associate have graduate training either in physics or in some field of engineering. They should also have some experience in the operation and use of experimental reactors and be licensed operators.

Operation

The next members of the staff are the licensed reactor operators. To provide continuity of operation it is essential that at least two operators be available. One serves as mechanic or electronic technician, while the other is stationed at the control panel of the reactor whenever the unit is in use. The operator on duty has direct responsibility for manipulation of the reactor controls; he also assists in loading the reactor core under the supervision of the reactor supervisor or his associate.

The next member of the staff is the reactor mechanic. He must be a skilled machinist, capable of performing both routine maintenance and repair of reactor components, including instrumentation, mechanical drives, and beam-hole equipment.

In addition to the reactor mechanic, it appears to be essential that an electronics technician be retained as a member of the reactor staff. It is his primary responsibility to maintain and make appropriate repair and modifications of the electronic instrumentation associated with the reactor. Both the mechanic and the electronics technician can serve as reactor operators.

To complete the reactor staff, a secretary, a building custodian, and some student or trainee help (two to five in number) are needed. This personnel is under the direction of the reactor supervisor.

In addition to the supervisory and operational staff outlined above, a health physicist is retained, answerable only to the laboratory director. The health physicist is responsible for maintaining safety standards both for operation and experimental utilization of the reactor. He serves as a member of the advisory committee, and is empowered to stop any operation which he deems to be of danger to reactor personnel or the community.

His duties include such things as the monitoring of outgoing shipments, supervision of spent fuel transfer, maintenance of safety records, experimental supervision as it relates to personnel safety, the establishment of monitoring techniques which protect the surrounding community, and responsibility for the maintenance of safety instrumentation. The health physicist must have at least a bachelor's degree in physics.

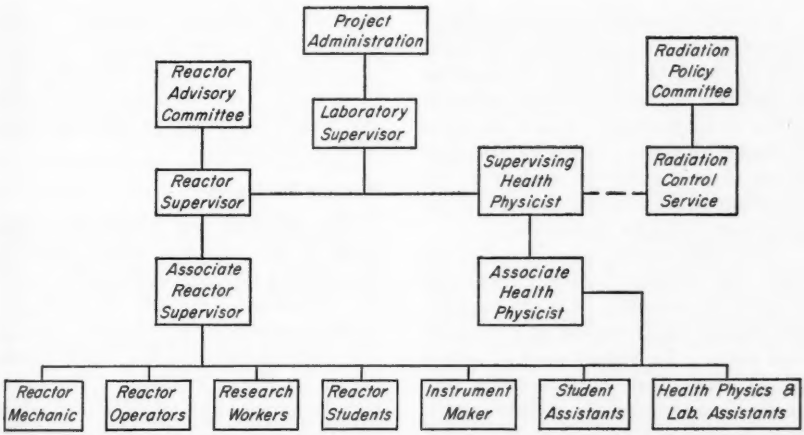
All personnel in the reactor laboratory building, except the health physicist, report to the reactor supervisor. The health physicist reports directly to the laboratory director and the advisory committee.

In summary, the minimum reactor staff comprises:

One Laboratory Director } These men may have teaching duties
One Reactor Supervisor } as well
One Associate Reactor Supervisor
Two Reactor Operators (half-time each—combined with next two positions below)
One Reactor Mechanic (half-time)
One Reactor Electronics Technician (half-time)
One Health Physicist (part-time on reactor)

One Secretary
One Building Custodian
Two to five student trainees.

The laboratory director and the reactor supervisor are available for "classroom" teaching. The remaining members of the reactor staff are not committed to teaching assignments, and thus provide a continuous operational program.



Organizational Chart of the Ford Nuclear Reactor Staff, University of Michigan

(1) The Reactor Supervisor has the responsibility of providing safe reactor operations.
(2) The Supervising Health Physicist has the responsibility of establishing and maintaining radiation safety.
(3) A supervising faculty member has the responsibility for the scientific and technical aspects of research.
(4) Any conflicts may be resolved through the Laboratory Supervisor's office.

SCHOLARSHIP FUND HONORS PROMINENT ENGINEER

Establishment of the Dwight D. Gardner Scholarship Fund was announced by the American Institute of Industrial Engineers just three days after the sudden death of Mr. Gardner, first elected President of the Society. The fund will be administered by a special committee under the direction of the AIIE Board of Trustees.

Some Comments on

HIGHWAY BENEFIT ANALYSIS

R. G. HENNES

Professor of Civil Engineering
University of Washington, Seattle

A principal problem of the highway economist is the appraisal of benefits. The decision to construct or improve a highway is based upon an estimate of the resulting gains; so is a selection between alternate routes or alternate types of improvement; and so is the adoption of appropriate levels of expenditure (design standards).

All of these policy decisions depend upon the balance between costs and returns, or benefits. Conventionally, this balance is expressed in a "benefit-cost ratio." To obtain such a ratio it is necessary that both benefits and costs be measured in definite units; these units must be such that a meaningful result is obtained by dividing the one quantity into the other.

Benefits may be tangible or intangible, primary or secondary; but intangible benefits cannot produce numbers for use in computing benefit-cost ratios, and secondary benefits, carelessly used, can introduce errors of double-counting. The anticipation of benefits in their totality is the only justification for highway expenditures, and the simple recognition of this prime fact is more important than either pedantic classification or meticulous measurement of benefits.

Modern highway textbooks evidence less awareness of the motives for highway expenditures than do the books written at the turn of the century. During the twenties engineers were kept too busy paving roads to be inclined to philosophize about them; and during the Great Depression of the thirties it was not expedient to consider indirect beneficiaries as a potential source of highway revenue. Consequently, highway economists have been concerned with the benefits accruing to highway users almost exclusively.

Present Problems

The problem was relatively simple back in the twenties when highway betterment typically consisted of paving an unsurfaced road. Then the resulting reductions in vehicular operating costs constituted the chief justification for the expenditure. The situation becomes more complicated when we face the task of relieving traffic congestion in metropolitan areas.

In such cases the analyst is often dismayed to discover that vehicles using the elaborate and expensive freeway may operate at higher (not lower) cost than they did over the previously congested city street. Operating at high speed can create a greater increase in cost than the saving realized by eliminating stops.

Nevertheless, the desirability of these costly improvements has been amply demonstrated by public willingness to pay tolls for the privilege of operating vehicles at lower efficiency. What motorists are buying, actually and obviously, is time-saving and a reduction of the personal strain and annoyance of congested, stop-start driving.

The evaluation of these amenity benefits is a most difficult problem, which, nevertheless, inescapably must be faced in every decision to build or not to build a modern expressway.

And there is no way for the highway administrator or planner to bypass this problem—he can only avoid quantifying it through a decision based upon intuitive judgment. This may be art, but is it engineering?

The very tough problem of measuring intangible benefits without any accepted unit of measurement is eased considerably in the case of toll roads. Here we know at least that the motorist demonstrably is willing to pay a set price, even though he may not be able to describe in meaningful terms what it is that he thinks he is buying. Toll charges can be broken down into cents per vehicle mile, and it may be sufficient for many purposes if we can establish the premium men would pay for fast, uninterrupted travel over roads built to definable standards of excellence.

There remains also a chance that something can be made of the probable relationship between time-saving and the elements of highway design that promote driver comfort. If so, conceivably time-saving might be credited not only with its own intrinsic value, but also with the value ascribed to freedom from driver tension and annoyance. Further research into this possibility might have value for benefit analysis.

New Needs

But benefit analysis today is finding another and equally important application in highway economics, an application not found in recent program planning. Section 210 of the Federal Highway Revenue Act of 1956 directs the Secretary of Commerce "to make a study and investigation of . . . the use of (Federal-aid) . . . highways and (3) any direct and indirect benefits accruing to any class which derives benefits from Federal-aid highways in addition to benefits from actual use. . . ." This benefit analysis is to be undertaken "in order to assure, insofar as practicable, an equitable distribution of the tax burdens among the various classes of persons using Federal-aid highways or otherwise deriving benefits from such highways."

In simple words, benefit analysis is to be considered as one factor in the allocation of Federal-aid highway costs. This analysis of highway tax *responsibility* will involve some modification of the procedures developed for the *justification* of proposed highway expenditures. In benefit-cost analyses, highway economists have been concerned primarily with primary benefits, both tangible and intangible.

There has been a reluctance to include such secondary benefits as the notable increases in real estate value which accompany many highway improvements: it has been felt generally that these secondary benefits are largely transferred—they occur not because of road improvements directly, but as a consequence of vehicular benefits which do accrue directly from the road improvement.

According to this view, if we placed additional taxes upon highway users to the extent of confiscating all user benefits from the road improvement, there would be no corresponding rise in real estate value because there would be no induced increment of traffic. Accordingly, to recognize secondary benefits in a benefit-cost analysis would be to count vehicular benefits twice, and thus erroneously to inflate the benefit-cost ratio.

Now when we direct our attention to the cost-allocation problem an altogether different situation is found. Here we want to recognize every determinable beneficiary of the highway expenditure regardless of whether he pocketed his dollar after its first or after its second bounce. Here, there is little risk of double-counting bene-

fits because we are interested only in the ratio of one sort of benefit to another sort; we are *not* summing up benefits to find the ratio of total benefit to total costs. Every unidentified beneficiary is a threat to sound policy because the prospect of profit without risk provides a strong motive to put pressure-group politics into highway planning.

The taxing problem is fully as complicated as any other sort of benefit analysis. Perhaps most troublesome of all is the intangible benefit of highways to the general public, although we must recognize that a highway system is essential to the national defense, to the maintenance of governmental functions, and to the very preservation of internal order. There is no semblance of agreement among analysts except, perhaps, a common disinclination to recognize the issue.

Possibly the most promising approach is the so-called "added expenditure" theory which would assign to the general public the cost of maintaining the road system which was deemed socially essential before the advent of automobile traffic and to divide the added expenditures, the great bulk of present-day highway costs, between user and benefited property in proportion to the respective benefits derived from these subsequent road and street improvements.

Before the federal highway-cost allocation study now in progress, there were a number of highway tax studies conducted in individual states by various consultants and commissions. Last summer, for example, we finished a three-year study of highway cost allocation in Washington State, utilizing specialized talents from various departments of the University and from the State College. ("Allocation of Road and Street Costs," Washington State Council for Highway Research, June, 1956.)

In scope, this study was much like the current Bureau of Public Roads assignment because it emphasized benefit analysis in determining the relative responsibility of highway users and others; and emphasized the "cost-occasioned" or "incremental-cost" solution to the problem of subdividing user-responsibility among the several classes of vehicles.

These and similar recent studies in the State of Washington may interest educators because of their interdisciplinary nature. Although administratively placed within the department of Civil Engineering, the research staff was composed of personnel from the College of Business Administration and from the College of Arts and Sciences in about the same proportion as from the College of Engineering. Only by crossing college lines can the resources of a university be fully mobilized for such assignments.

Diversity in attack confers a greater measure of objectivity in research by neutralizing the bias characteristic of each individual discipline. The general tax theorist, for example, is apt to oppose the segration of highway user fees because of his opposition to earmarked taxes, until he appreciates the problems of the highway planner and utility aspects of the highway operation.

Similarly, most economists seem rather to view highway user fees as more properly established by a form of economic pricing of highway service, so that the user tax would serve as a tool to encourage the expansion or reduction of highway usage in the achievement of an efficient utilization of resources. They do not see highway taxes as a problem in the recovery of highway costs according to benefits received or in proportion to costs occasioned.

Despite any theoretical appeal

which this viewpoint may possess for the economist, there is reason to believe that the growing tendency to rely increasingly upon user fees for highway revenues creates needless difficulties for the highway administrator in planning expenditures, because beneficiaries who are not taxed are in favor of higher standards and different routes than would be the beneficiaries who are taxed.

Moreover, neutrality between competing forms of transportation would seem to demand that commercial users be charged only with those costs which their needs have occasioned. A contrary policy that would have the highway user subsidize real estate promotions would place the user at a competitive disadvantage. Speculators and promotors would receive less popular support in their efforts to influence planning if highway financing always reflected highway benefits. Benefit taxation would provide needed roads sooner, in logical locations.

TAX DEDUCTION INCURRED IN SOCIETY ACTIVITIES

The following information has been confirmed by the EJC legal counsel:

"The Internal Revenue Service under ruling 55–4, I.R.B. 1955–1 states that a taxpayer 'who gives his services gratuitously to an association, contributions to which are deductible' under the relevant provisions of the Code 'and who incurs unreimbursed traveling expenses, including the cost of meals and lodging, while away from home in connection with the affairs of the association and at its direction, may deduct the amount of such unreimbursed expenses in computing his net income'; subject, however, to the limitation in respect to all gifts made to exempt organizations of this type; namely, that the total amount of such gifts made in any one year may not exceed 20 per cent of the donor's gross income for such year. This limitation means that while such expenses are deductible, they are included with other gifts in computing the 20 per cent limitation."

ASME APPOINTS SECRETARY

O. B. Schier, II, has been appointed Secretary of the American Society of Mechanical Engineers, succeeding Clarence E. Davies who held this appointment for 23 years. The announcement was made December 30, 1957, by James N. Landis, President of the 50,000-member society.

The Significance of

MECHANICAL PROPERTIES IN TEACHING MACHINE DESIGN

JOSEPH MARIN

Professor and Head
Department of Engineering Mechanics
Pennsylvania State University

Adapted from a paper presented at the 63rd Annual Meeting of ASEE held in June, 1955.

Recent domestic and military developments have made it necessary to consider more thoroughly the mechanical properties of materials in the design of machines and structures. New designs, changes in operating conditions of existing designs, and the development of new materials makes it mandatory to consider mechanical properties of materials. The modern machine designer must consider results of current research on material properties in order to meet the extreme conditions of service encountered in many modern machines.

This paper outlines the reasons for considering mechanical properties of materials more thoroughly at the present time than in the past. Examples are given where the results of research on mechanical properties of materials can be more generally used in the teaching of machine design than is now the case. Finally, it is recommended that university curricula in Mechanical Engineering be changed to incorporate a course on mechanical properties of materials as a prerequisite to the study of machine design. This course would not be of the usual general descriptive type, but analytical in approach with emphasis upon mechanical properties of materials.*

In discussing the importance of mechanical properties of materials in machine design, it is realized that other properties and other considerations may sometimes govern the sizes of machine parts. However, many situations occur where the safety or economy of a design results from a thorough consideration of mechanical properties. In the design of machine components for adequate strength, the modern designer has available considerable information that was not available 20 years ago. New methods of vibration and stress analysis have been devised using both theoretical and experimental approaches. These methods have been applied in recent years to the vibration and stress analysis of many specific machine parts. However, research results on material properties have not been fully utilized in the teaching of machine design. This inadequate consideration of materials research is probably due to the many engineering developments that have occurred in a relatively short period of time.

Recent Engineering Developments

Factors contributing to the increased importance of mechanical properties in machine design include:

* This type of course is described in the paper "A New Type of Course in Engineering Materials" by Joseph Marin and J. A. Sauer, *Journal of Engineering Education*, Vol. 41, No. 2, October, 1950, pp. 81–87.

1. *Changes in Operating Conditions.* In recent years, the severity of operating conditions has increased for many modern machines. Increased speed of operation has required a more thorough consideration of fatigue properties of materials. New machines and constructions have also been designed for more severe impact and shock loading conditions necessitating considerations of impact properties.

A large group of new applications operating at very high temperatures have increased the importance of high-temperature properties and creep in machine design. Some of these applications include gas and steam turbines, rocket and jet engines, nuclear energy equipment, and high-temperature equipment used in the chemical industries. In some cases, combinations of high temperature and fatigue or high temperature and impact exist and the properties of the material under these combined effects must be known.

The increased use of materials in constructions operating in low-temperature environments has also necessitated a consideration of low-temperature properties. It is found that at low temperature, ductility and sometimes toughness of materials are considerably reduced.

2. *Development of New Materials.* The many new materials developed in recent years include super alloys with ultimate strengths exceeding 350,000 psi, high-temperature-resistant ferrous alloys; cermets and ceramels consisting of combinations of metallic and ceramic materials, and possessing superior high temperature-resisting properties; plastics of various kinds such as nylon, orlon and plexiglas, which have special mechanical properties and adaptibility to fabrication in various forms; various lightweight alloys including alloys of aluminum and magnesium combining superior strength with light weight; and nonmetallic combinations such as prestressed concrete and plywood with special fabrication advantages.

The designer can no longer rely on past performance, for when a new material is used, the mechanical strength must be based on a consideration of the mechanical properties. The mechanical properties are also important when a selection of a material is made. The progressive designer realizes, of course, that a new design utilizing a new material may often require various types of mechanical tests. That is, in addition to laboratory tests on samples of the material, it is desirable to conduct tests on actual parts as well as service tests of the entire machine.

3. *Development of New Machines.* The recent development of many new machines has required the selection of the most suitable materials for the particular operating conditions expected. An important guide to selection is the knowledge of mechanical properties gained in laboratory tests.

Other developments which have increased the need for information on mechanical properties of materials are: *scarcity of materials, the need for substitute materials, and demands for greater safety and economy brought about by increased competition.*

Utilization of Properties in Design

The illustrations outlined below indicate how results obtained on the mechanical properties of materials can be utilized to improve instruction in machine design. They are selected for various types of loading conditions.

1. *Static Loading.* Tensile stress-strain diagrams can be obtained in which the determination of true stress and true strains is based on actual

cross-sectional dimensions and gage length rather than original values. Based upon true stress-strain diagrams, a more accurate measure of ultimate strength, ductility and toughness can be evaluated. It is recommended that, for purposes of material selection, the properties based upon the true stress-strain diagrams be used rather than the nominal values.

In design of machine members subjected to combined stresses, it has been customary for many years to use the maximum shear theory to define failure by yielding. Codes such as the ASME code for transmission shafting and the ANC code for aircraft design specify the shear theory. Although this theory gives results on the conservative side, investigations show that the distortion energy theory is in better agreement with the test data.

The use of the distortion energy theory for two-dimensional cases is recommended, not only because it is in closer agreement with test results, but because only one relation need be used, whereas with the shear theory, three possible maximum shear stresses must be considered. It is not clear to the writer why some machine design books use both the maximum shear and maximum stress theories in the design of machine elements.

In recent years, there has been an increase in the number of applications in which residual stresses are intentionally introduced in a structural or machine member in order to improve its strength. Piping, rotors, thick-walled pressure vessels and guns are a few of the many applications where residual stresses are applied to improve strength. These residual stresses are either applied using an elastic shrink-fit condition, as in rotors and composite guns, or plastic flow of the material is initially produced so that on the release of this load, a favorable residual state of stress is produced.

In order to decide on the amount of preloading, the designer must have knowledge of the plastic flow of metals and theory of plasticity for both simple and combined stresses. Information on theory of plasticity and plastic properties of materials has also become important in rolling, forming, forging and other fabrication procedures.

2. *Fatigue and Impact Loading.* The utilization of fatigue test data in machine design may be done in various ways. It is suggested that consideration be given to such matters as: the use of fatigue strength based on a finite life (as used in rating of ball bearings) rather than on infinite life, the rational design of parts for situations with varying stress amplitudes based upon approximate methods that have been developed for this purpose, and the use of empirical relations for strength in the case of superimposed fluctuating and static stresses. A more rational consideration of combined fatigue stresses than is provided by some codes is also recommended. For example, theories are available for defining strength under combined fluctuating stresses superimposed upon combined static stresses. These theories give a more accurate design than procedures evolving the use of the static shear theory with a selected shock factor.

In recent years, more information has been obtained on the impact properties of materials. Methods of stress and strain analysis for impact have also been developed that were not available until recently.

3. *High Temperature and Creep Loading.* With the increased use of materials at elevated temperatures, it has been necessary to evaluate the properties at elevated temperatures. Two important properties that are evaluated are the stress-time to rupture and the stress-creep-strain-time

relations. These relations are required as a basis for design since the working stress must be based on a failure stress value corresponding to fracture or a limiting creep deformation. Other elevated properties such as yield strength, toughness, and ductility may also be determined.

In the design of parts to resist creep, the machine designer has available information on the mechanics of creep. These theories provide means of determining creep stresses and deformations in various types of machine members.

4. *Low-Temperature Loading.* Although the strengths of materials are somewhat greater under low temperatures than at room temperature, the increases are not sufficient to justify an increase in working stress. In fact, the great reduction in ductility and toughness that occurs in materials at certain critical transition temperatures may justify a reduced working stress. A measure of the reduction in toughness is afforded by the notched bar impact test conducted at a series of low temperatures. A plot of temperature versus impact toughness shows a transition temperature where further decrease in temperature greatly reduces toughness. This type of test may be used effectually for material selection where a design for low temperature conditions is desired.

OFFICERS NOMINATED FOR 1958-59

The Nominating Committee met in New York City on Saturday, October 26, 1957 and selected the following candidates:

For President, one year ..... William T. Alexander
Dean of Engineering, Northeastern University, Vice President, ECAC, 1955–57; member, 1929.

For Vice President, Sections West of Mississippi River, two years ..... Clarence L. Eckel
Deans, College of Engineering, University of Colorado; Vice President, Sections West of Mississippi River, 1957–58; General Council, 1934–37; member, 1914.

For Vice President, Instructional Divisions .... Elmer C. Easton
Dean of Engineering, Rutgers University; Member General Council; Chairman, ECAC Accreditation Committee, member, 1946.

For Treasurer ..... John Gammell
Director of Graduate Training, Allis Chalmers Manufacturing Co.; Treasurer 1955–57; member, 1949.

In accordance with the revisions of the constitution and by-laws adopted in June of 1957, *additional nominations may be made by petition* of fifty (50) signatures of members of the Society in good standing. The nominee must indicate a willingness to serve, if elected, before his name can be placed on the ballot. Petitions are to be submitted to the Secretary of the Society by January 15, 1958.

In the March issue of the JOURNAL OF ENGINEERING EDUCATION ballots giving the names of all candidates will be provided. Ballots received by the Secretary by March 31 shall determine the election of the officers as of April 1. Their terms of office shall begin ten days after the date of the annual meeting.

HAVE YOU *WRITTEN* YOUR PAPER YET?

WARREN H. CRATER

Newark College of Engineering (General Editor)

MARGARET D. BLICKLE

Ohio State University, Columbus

PETER L. BALISE

University of Washington, Seattle

Though the 1957 YET paper judges have modestly restricted their comments and suggestions to the YET Contest, their remarks may well be of general interest to all who wish to write for publication. A more detailed discussion in terms of editorial standards and usability is presented in the JOURNAL *author's manual,* available on request.

Last year the three authors of this paper shared an interesting experience as judges of the Young Engineering Teachers paper contest, and we are looking forward to the same pleasure this year. Out of our work together has come the suggestion that some of our observations may be of value to those who are planning or are putting the finishing touches on papers to be submitted to this or any other learned society.

We are, of course, happy to discuss the criteria which we used—and expect to use—in our own judging, but do this humbly. Though we are not reluctant to describe what we found in the YET papers, we think it out of order to give rudimentary instructions on the writing of papers to qualified members of a professional group.

Speaking first not as judges but as members of sections and divisions from which papers originate, we suggest that too few young teachers are availing themselves of the opportunity provided by the YET contest; perhaps they feel that they will be competing with veteran engineers and scholars whose standards are unattainable by younger men. But we have not found the youth of YET contestants to be a liability; quite the contrary.

We would like to emphasize that a man with an idea is a force to be reckoned with, whether he is young or old. Add a dash of originality and freshness, and his paper will get the recognition of his ASEE section and will be submitted to us along with other winners for final judging. If he is among the national winners, his paper will be read at the annual meeting and published in the JOURNAL.

If an author thinks his idea is good and if he feels it will enlighten the reader, it will probably be suitable for a paper. There are so many facets to engineering education that a sincere teacher is not likely to err in his choice of topic. We can think of no paper disqualified because of its subject matter. For what seems at starting to be a dull and unimportant subject often comes alive through the contagious enthusiasm of its author. To give some idea of the range of subjects in the winning papers which came from the sections last year, we record their titles here:

Encouraging Engineers to Talk
High School Preparation for Engineering

The Teacher Shortage in Engineering Colleges
Increasing Laboratory Effectiveness
Need for Creative Approach to Engineering Education
The Complexity of Teaching
Systems Engineering in the Undergraduate Curriculum
Making Teaching More Attractive
Accepting the Challenge of Teaching
Discussion of a Regional School Laboratory
A Plan for Integration of Courses
Engineering Education at Crossroads

The new brochure, "Paper Contest for Young Engineering Teachers, 1958," gives an interesting list of promising subjects. A copy can be obtained by writing to the Secretary, ASEE, University of Illinois, Urbana, Illinois.

Judging Criteria

As judges we attempt to read these papers with the eye of the professional audience to whom they will ultimately be submitted. If a subject seems on the surface to be worn out, the audience's first reaction will probably be: "No, not this *again*!" If, on the contrary, it is a drastic one, the audience may shrug it off with "Perhaps he would like to eliminate the professor, too." Such extreme possibilities must always be considered. Professional men are both cautious and discriminating. Give them a trite subject and they ignore it; face them with a startling new idea and they are fearful lest sound traditions are being undermined.

Having passed the first hurdle—the choice of subject—a few papers fail to provide introductions, with statements of aims and definition of terms, and so give us little with which to measure or follow the thought as it develops. Particularly in those papers dealing with abstractions in educational philosophy and the like, introductory statements made with less than the greatest clarity often give a paper a handicap which is impossible to overcome. As brilliant as a thought may be, if it is not focused properly in the first few lines, it runs the risk of becoming a lost thought.

We have mentioned enthusiasm. Sometimes it appears as a burst of light in the first few paragraphs, then disappears for good, leaving behind little to sustain the reader through ten or more additional pages. On the other hand, at times it is sustained at such heat that it smothers the main thought. Interest lags as readers grow weary of trying to separate the glow of the writing from the substance of thought.

As judges we do not hold that a paper must be dull in order to be scholarly, but like any other readers, we have difficulty when points are not made in intelligible order and the subject blurs before our eyes. We become confused, for instance, if one and the same idea is variously referred to as "engineering teacher," "we," "the college," "the teacher," "the institution." A writer should be consistent; otherwise, before he knows it, he will have stretched his concept to cover so many subjects that it falls asunder, and the words become meaningless or without clear application.

A few writers neglect to take note of the gap between their own devotion to the subject and the reader's merely casual interest—between their personal experience and the possible inexperience of the reader. In this situation *illustrations* are useful, for they lead the reader from the familiar to the unfamiliar and thus help to establish a common meeting ground.

For instance, the plight of the impoverished, overworked professor will

get through to us more clearly if a specific instance from history, literature, or personal experience underscores it. Concrete examples of actual classroom situations, as opposed to pages of generalities, speak loudly. Statistics help, too. We are not suggesting, of course, that a good writer treats the intelligence of his audience lightly by loading his paper with empty anecdotes and superficial surveys; but we have seen in some of these papers good thoughts stagnating because their many pages of abstractions make no contact with the experience of the reader. Sometimes sheer concentration and compression would help, too, so that many diffuse pages become a few clear ones.

If we were editors rather than judges, we might cut out whole paragraphs, or pages as well as words, phrases, clauses, or even sections from some of the papers submitted. What appears too short to the writer often appears too long to the reader. Even the best papers usually can profit by some blue-penciling. In a few cases, the tendency to decorate with platitude and witticism is so marked that these ornaments crowd out or becloud essentials. A few writers even lose sight of what they intended to do: three or more solutions or questions are proposed in the beginning; with no explanation, all but one disappear before the end.

It is a sad truth that professional men are not immune to attacks of pedantry, and it shows up, in varying degrees, in these papers. Educators are frequently not quick to see it in their own style, but as expert fellow-sufferers they are quick to detect it in the writing of others. Some of the most successful YET writers tell us that they are so blind to this weakness in themeselves that they must rely on their colleagues and friends to point it out to them. They are wise to do so.

As judges, we scan closely for jargon, too. It is hard to say which strikes the harshest note—the traditional jargon or the latest very cant expressions. Fad words too often seem to be used in an attempt to cover up vague thoughts. Yet technical papers can be written forcefully without these defects.

Scientific American, for example, belies the thought that there can be no high literary standards for technology and science. Among the papers submitted to us, there is additional proof that scholarly articles can move at a brisk, interesting pace, with clear concepts and simple language; but there is also evidence of a tendency to resort to the language of the expert, which only the initiate can understand.

In 1721, in his "Letter to a Young Clergyman, Lately Entered into Holy Orders," the great Jonathan Swift, clergyman as well as author, took the members of his profession to task for their error in making a distinction between the professional and the layman:

"But I know not how it comes to pass that professors in most arts and sciences are generally the worst qualified to explain their meanings to those who are not of their tribe; a common farmer shall make you understand in three words that his foot is out of joint, or his collar-bone broken; wherein a surgeon, after a hundred terms of art . . . shall leave you to seek. It, is frequently the same case in law, physic, and even many of the meaner arts."

In Summary

There is much about the writing of papers which has not been said here, particularly about the preparation of manuscript, the use of proper grammar, the intelligent ordering of thought. While we have been dis-

tressed by the frequent departures from the accepted mechanics of writing, we do not presume upon the intelligence of otherwise competent teachers beyond mentioning that where such defects are present, they are unfortunately effective in nullifying the impact of the most interesting idea.

We have also not dealt with the oral presentation of papers. In general we feel that a well-written paper will be a good basis for a spoken presentation, but that it should seldom if ever be literally read to an audience. This subject is ably discussed by Harold O. Haskitt, Jr. in the January, 1957, issue of the JOURNAL—"So You're Reading a Paper."

Although the evidence upon which we have drawn comes largely from YET papers, we feel that the issues discussed are significant for all writers regardless of their age or the destination of their papers. We would emphasize that we have no private formula for writing the perfect paper. If we three—a technical writer, a mechanical engineer, and a humanist—possess any special wisdom, it has come to us as a result of our experience as judges. We have listened also to our share of scholarly articles; thus we are probably as well conditioned as any to speak for those who look forward to a good paper and most desperately hope to avoid being exposed to a bad one.

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Office of the Secretary, University of Illinois, Urbana, Illinois

WHAT DOES INDUSTRY WANT IN ENGINEERING GRADUATES?

JOHN WEIKART

Esso Research and Engineering Company
Linden, New Jersey

Presented at the Chemical Engineering Dinner, June 18, 1957; recommended by the Division.

This is currently a very popular subject. Ask any industry man and you can have quite a few comments. Some of these may lead you to think we want a well-educated chemical engineer with five years' experience.

Generally, we agree that the colleges are doing a good job. Proof of this is the tremendous expansion in the chemical, petroleum, and allied industries. Not just increased production, but new and better products. We all recognize the advances in things we wear, better building materials, better transportation, even things we eat. Much of this is being done by the chemical engineer.

But we can't stand still; we must keep on improving. With the strong points there also may be weak ones.

Our Company has looked into this. We asked our recent graduates, and their first- and second-line supervisors, to fill out an anonymous questionnaire, of which results pertinent to ASEE are presented below.

Discussion

What do the recent graduates do? 60% of their time is spent on collecting data, correlating, calculating, and interpreting them. Another 30% is spent on writing reports, or letters, and in selling the results to others. The main point is that engineering work is mostly technical. The men quizzed have done this technical work. We asked them what Chemical Engineering and Chemistry courses were most important in a four-year B.S. curriculum. Their top three replies placed in the following order:

1. Unit Operations.
2. Chemical Engineering Design.
3. Organic Chemistry.

They were also asked for non-chemical but technical subjects. These placed in the order:

1. Differential equations.
2. Theory of statistics.
3. Theory of instrumentation.

The replies have included both fundamental and applied courses. Actually, I think the selected applied courses such as unit operation, chemical engineering design, and theory of instruments embrace the basic fundamentals of physical chemistry, thermodynamics, and kinetics. The other fundamental course, mathematics, is mentioned twice, differential equations and statistics. Other questions (4 vs. 5 years) also emphasized the desire for more mathematics and more engineering.

Supervisors were asked for their views on training of young chemical engineers. This is the company or management view of what is most important:

1. Unit operations and unit processes.
2. Chemical enginering design.

3. Organic Chemistry.
4. Physical Chemistry and Kinetics.

Note the agreement between the engineers and their supervisors.

In non-chemical but technical subjects, supervisors designated mathematics by a wide margin. No specific mention of statistics (graduates' second choice) or instrumentation (graduates' third choice) was made by the supervisors.

This is good agreement. The supervisors of the Company bring out the need for a sound background in the fundamental sciences and their application in engineering fundamentals. The graduates agree they need just this to do their technical job.

Companies further agree that the courses should be woven together; they should bring out the use of fundamentals in the teaching of the later courses, show the intimate relation one with another. An example of this is a plea for a well-integrated program in teaching physical chemistry, thermodynamics, and kinetics. They should not be treated as abstract subjects but should be well interwoven.

Technical Judgment

The supervisors of the Company were in agreement about one technical weakness—technical judgment. In our study this weakness was mentioned just about twice as much as the next technical weakness—organization and planning. The 24 industry people at a recent Cornell conference on this subject also stressed the need for good technical judgment. True, technical judgment comes with experience, but we feel students should get some practice in school, too.

In industry, our people have to select the pertinent data from a mass of often extraneous information. We often have to make a quick approximation of the answer. Then we have to evaluate the answer. First, is it reasonably accurate; is it worth doing more accurately; is there a payout for the detailed calculations to get a more accurate answer? Also, if we make such an approximation, can it be right or is it away off because of missing data, a poor assumption, or what have you? We often have jobs that have more than one solution; we need the optimum. We have to use judgment.

We also want some creativity here, too; not research, but some imagination in our approach to problems. For example, one problem might be the design of a distillation tower. Assume that expansion is going to occur as the market develops from a different local area. A quick thought suggests putting in an oversize tower with minimum pumps, exchangers, and so on.

We might put in pumps with spares and when expanding we would add another spare. The original two pumps could operate in parallel with the third as a common spare. I wonder how far the students could take this one. A further qualification would be freight rates to distant new markets. Is it better to plan on new capacity at the original site, or is a new site preferable?

I'm reminded of one about a pipeline across a stretch of desert, say Arabia. I had this one in school. We were given the desired capacity, cost of pipe, cost of pumping stations, and asked to establish the optimum pipe size and number of pumping stations. Today I'd add something more to this. I'd point out that all the pipe had to come from the U. S. I'd specify the cubic footage and weight capacity of ships plus the cost.

I wonder how many of the students would think to specify two pipe sizes so one could slide inside the other and you could carry nearly twice as

much pipe per ship. This brings out the creativity, the imagination. This problem could be further qualified by adding the probable tax future of certain middle-east countries; route selection then becomes a major part of the problem.

Another problem that is perhaps peculiar to us is handling fluidized solids. We carry them from place to place in pipes, which must go around bends. If we were to use elbows, we wouldn't for long. This kind of service takes a gradual bend. How gradual should it be? This is an interesting design problem.

These are really projects, and we think they will develop the thinking, judgment, and imagination we want so badly. This should be carried into examinations. Open-book examinations are to be commended. They don't limit the available data to a few pertinent points, but require a knowledge of the subject and where to look for information.

Communications

Now let's leave the technical work and move to the writing-speaking part of the young man's job. In our survey, this part of the job took 30% of the man's time, an important part.

Most of the information we develop in industry is not used by the man himself, but rather by his immediate associates and by his supervisors and often by a customer. Answers therefore must be communicated. Most often, it is not a simple answer but one involving judgment and decisions.

So background, method, and technique must be communicated along with the answer. The results must be presented, even sold, in a neat and logical manner, either orally or written or both. This is true not only for a big project but also for smaller pieces of overall big projects.

Written records are probably most important. In oral presentations, an unclear point or an area of confusion can be cleared up by discussion or questions. The written record must stand on its own feet.

Many graduates are weak in this area of written records. Referring to the supervisor questionnaire, we note that this weakness was cited most frequently—twice as often as technical judgment—and oral presentation was right behind. 45% of our supervisors listed writing as a weakness.

Clear, effective writing is a combination of good arrangement and good vocabulary combined with good English grammar. Arrangement is needed to provide a path for the reader's thinking, much as mathematical methods do with numbers. Vocabulary is extremely important. The use of well-known words with a reasonable amount of color but without a lot of polysyllables is the foundation of good undestanding.

For example, a foreign-born plumber in New York wrote the Bureau of Standards that he found hydrochloric acid fine for cleaning of drains, and did they agree? Washington replied: "The efficacy of hydrochloric acid is indisputable, but chlorine residue is incompatible with metallic permanence." The plumber wrote back that he was mighty glad the Bureau agreed with him.

Considerably alarmed, the Bureau replied for the second time: "We cannot assume responsibility for the production of toxic and noxious residues with hydrochloric acid, and suggest you use an alternate procedure." The plumber was happy to learn that the Bureau still agreed with him. Whereupon a more practical correspondent in Washington wrote: "Don't use hydrochloric acid; it eats hell out of the

pipes!" There is little room for misunderstanding in this last sentence.

This is nothing new to the professors. Every day they practice good oral communications in their lectures. They have learned through education and practice. The boys need both, but practice in technical communication is what they need most.

Our young employees write many reports. We suggest they be marked on presentation as well as on technical contents. We suggest that the form of the report be varied. We have to write to many different audiences. Sometimes we must give all the details, somtimes just the most pertinent thinking and conclusion.

This short one is the tougher job. In unit operations reports, consider selecting one or two projects for a one-page report with perhaps one attached page of highly pertinent calculations. The main thought here is to get away from stereotyped reports. I cannot overemphasize the need for good training in communications. I wonder how much good, sound technical work has been lost because of poor communications.

Personality Characteristics

Human relations is an important part of our business. Most of our work is technical work, but closely interwoven is the day-to-day contact with our fellows.

The young man's personality characteristics are very important. These fellows are going to have to fit in. They will be important members of teams. They are going to associate with other new professional people and with their supervisors. This isn't new. This they have had in college with their fellow students and with you professors. The more contact they can have with the professors, the better for their personal growth.

There is one new area, though—the non-professional men, the technicians. With these technicians, the new professional men will be looked up to as members of management and they must act it. At the same time, technicians are often older, mature men, and the professional is just a young snip to them.

The new man has much to learn from these technicians; they are skilled workmen. He will learn about the business and also get his first dose of how to handle people. This contact with the non-professional people also brings up the subject of union-management relations. Some exposure to this subject might be worthy of consideration by the colleges. Not a full course, perhaps, but something more than a newspaper version of it.

Summary

We want a man who is well grounded in the fundamentals of engineering, science, and mathematics. Not only do we want it but both the new engineers and the supervisors recognize it as a prime prerequisite. We think a good job is being done here. Keep it up; don't let it slip. As our college populations go up, there will be strong temptations to ease up here and there, but we can't afford it.

We would like the graduates to have a little more experience in technical judgment. This requires practice. One industrial representative at the Cornell conference on Chemical Engineering Education compared this to golf. You can learn the fundamentals from the best professional in the world, but you've got to practice to be a good golfer. We want the boys to exercise judgment; we need to give them practice.

Good communications, both written and oral, are becoming increasingly

important. We are growing and our work is becoming more complex. To do our jobs right, we must have information; we must communicate with each other. The students need help here.

The man must be a human being. He'll work with equipment—true, but he's in constant contact with his fellow man, both in and out of work. We want good technical men, not machines. They must be socially responsible human beings, too.

Wrap this all up and then lace it with enthusiasm, good work habits and a continuing desire to learn, and you have what industry's personnel recruiters are seeking.

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ENGINEERING SCIENCES IN THE IDEAL CURRICULUM

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Presented at the New England Section meeting, October 12, 1957, at Amherst, Massachusetts.

The great inventions of the 19th century—the railroad, the steamboat, the cotton gin, the telegraph, the telephone, the electric light bulb, the mechanical reaper, the automobile—all resulted from application of the mechanical ingenuity of individuals. These great inventions were not brought about by the application of scientific principles in a carefully organized attack on a specific problem.

Organized research did not begin until the turn of the century when the Germans set about development of an economically competitive method for production of snythetic indigo. Their goal was accomplished with German thoroughness, by the expenditure of many man-years of coordinated effort and about $5,000,000.

This achievement, and others which followed, led to German preeminence in the dye-stuff field and in allied areas, including explosives. More important, it served plain notice on the rest of the world that to compete with Jerry, similar methods would be required. The lesson was underlined by World War I, which Jerry came within an ace of winning, thanks to his technological superiority.

The result of all this has been a period of technological advancement staggering in its proportions. The airplane was born only 54 years ago, radio about 10 years before that. Synthetic textiles, rayon excepted, are no more than 20 years old, and the first atomic reactor was built just 15 years ago.

As a measure of how far, and how fast, technology has advanced, consider that aircraft are now being flown at least twice the speed of sound. Intercontinental ballistic missiles are an imminent reality and the Russians have flung two earth satellites out into the blue. Small-scale atomic power plants are in operation and bigger ones are being built as fast as justification and money for them can be found; scientists are reaching for control of the virtually unlimited power in the fusion reaction. Some even think that man can make rain. Obviously, the end to wonders is not yet.

This is not the world many of us were educated for. We studied railroad construction when we should have studied railroad demolition. We made contour maps on a plane table which now are made a thousand times faster, and perhaps twice as well, by photogrammetry. MIT is going a big step beyond that with a scheme for feeding air photographs to a computer and coming out with a highway profile, alignment, slope stake data, and a complete list of construction quantities in about the time it would take an old-time draftsman to sharpen his pencil. Properly constructed, the same computer will solve electrical or piping network problems, design frames with rigid joints, analyze a mass of concrete test reports, or route a flood through a reservoir, in the twinkling of an eye.

Advances and profound change are

everywhere, and this is only the beginning. One advance begets another, one discovery makes others possible, and one change forces many others. Look, for example, at what the automobile has done to our whole economy and pattern of living.

Applications Become Obsolete

It is impossible to predict what will come in 20 years, or even in ten, with sufficient certainty to justify specific application courses. The needs cannot be anticipated. Much of the detailed knowledge that engineers now in school will need a decade hence does not even exist today. Conversely, some of the current applications included in engineering curricula will certainly be obsolete by then, at least in their present forms.

For these reasons particularly, and because the student can never know for certain what his field of practice will be on some uncertain day in the future, the present trend toward increased academic emphasis on mathematics, the basic sciences, and the engineering sciences, is all to the good. These are the foundation stones on which the art of engineering rests.

It is to the firm base these disciplines provide that the man faced with a new and confusing problem must return for an adequate solution. Real progress in the art must derive from fundamentals.

Unfortunately, the present trend toward increased emphasis on mathematics, the basic sciences, and the engineering sciences seems, unfortunately, to be largely in the paper and discussion stage, with considerable opposition in many quarters. This is understandable. The practicing engineer wants the new graduate he has employed to be able to step in immediately and provide real help with the work at hand. That is what he was hired for. Thus, strong pressure is exerted on the colleges to continue to teach application courses. It is a short-sighted view, and it tends toward the production of technicians rather than engineers, but its existence must be recognized as a potent factor.

Ideally, mathematics, basic sciences, and the engineering sciences should constitute about 50 per cent of the student's academic work. It is a little hard to distinguish the dividing line between basic science and engineering science. Where physics ends and electricity, dynamics, thermodynamics, or statics begins, for example, is quite immaterial. And mathematics, as the common language of science and engineering, properly belongs in the same group.

Survey of Basic Studies

A recent analysis of the civil engineering curricula at seven representative schools revealed that the percentage of the curricula devoted to these basic studies was well below the ideal suggested here. The schools were selected geographically: two from the middle west, two from the southeast, and three from the northeast. The results were as follows:

	Average	Range
Mathematics and Basic Science	26%	21–30%
Engineering Science	14%	7–21%
Application Courses	44%	37–56%
Cultural and Humanistic Courses	16%	13–18%

The average is 40 per cent of the curriculum for basic science, mathematics, and engineering science combined, with ranges among the seven schools extending from 30 to 47 per cent. If these figures are to be raised, the time will have to come from the application courses, unpopular as that shift might be. At the risk of all sorts of unpleasant accusations, one might also suggest that a long look be taken at the number of class hours devoted to military training and physical culture in the engineering colleges.

ENGINEERING SCIENCE IN CIVIL ENGINEERING

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The position of the engineering sciences in Civil Engineering has been questioned by many, and some have been vigorous in criticizing that branch of engineering for what appears to be a deficiency in this area. A great deal of the difficulty is due to the lack of an all-inclusive definition of the term, engineering science.

While a positive definition may be lacking, it *is* possible to decide with some authority what is *not* engineering science. According to considered opinion, engineering science is *not* mathematics, physics, or chemistry. On the other hand, engineering analysis and design are not a part of this type of instruction either.

It has been assumed by many that most engineering courses which fall between these two extremes in an engineering curriculum either are engineering sciences or should be taught as such even though they may not have been in the past. Indeed, certain courses of this group have been definitely classified as engineering science and have been enumerated as follows:

1. Mechanics of Solids (Statics, Dynamics, Strength of Materials)
2. Fluid Mechanics
3. Thermodynamics
4. Transfer and Rate Mechanisms (Heat, Mass, and Momentum Transfer)
5. Electrical Theory (Fields, Circuits, Electronics)
6. Nature and Properties of Materials (relating particle and aggregate structure to properties)

That the six areas of engineering science listed are not interpreted as being final is indicated by ECPD, with the qualifying statement that "Because some engineering curricula are built in part on sciences not included in the preceding paragraphs, such curricula may contain for additional flexibility other basic or engineering sciences appropriate to their field." ("Additional Criteria for Accreditation," JOURNAL, Vol. 46, No. 9, May, 1956.)

Each curriculum in the various colleges of engineering has anticipated the "Evaluation Report" for many years by providing a group of "buffer" courses between the engineering sciences and the design courses. As far as Civil Engineering is concerned these courses have had the purpose of providing better preparation in selected areas of engineering science.

For instance, Theory of Structures is in the Civil Engineering curriculum for the express purpose of securing more competence in Statics. Likewise, Theory of Reinforced Concrete is necessary to raise the level of qualification in Strength of Materials, with particular reference to members composed of two materials. On this basis, those who are responsible for knowledge in Civil Engineering consider Theory of Structures, Theory of Reinforced Concrete, Soils Engineering, Geology, Plain Concrete, Indeterminate Structures, Hydraulics, Hydrology, and similar courses as properly belonging in the engineering sciences

or coming within the qualifying statement of ECPD recommendations.

Criticism is directed towards these courses largely by those who prefer deductive reasoning, since no one can deny that this portion of the Civil Engineering curriculum is taught from the inductive point of view. This approach to instruction can be explained by considering the task of the Civil Engineer.

Until recently he has been engaged in developing facilities in underdeveloped areas to permit easier access to industry, commerce and culture. The speed with which this has been done did not permit the deductive approach.

There has been constant pressure, which still exists on many frontiers, to get the job done. The whole of the engineering profession can be justly proud of what has been done, and of the manner in which the Civil Engineering task has been accomplished.

It is true that most of our research has been directly related to obtaining facts from which generalizations could be made. It must be emphasized, however, that the magnitude of our accomplishments with this form of attack has obscured the constant attempts to solve our problems inductively since the days of Euler. As examples of the accomplishments referred to, Hoover Dam, the Golden Gate Bridge, the Empire State Building, and our rapidly growing highway system can be cited.

Furthermore, it must be admitted that most of the research money available today is for the purpose of seeking empirical solutions from the inductive type of program. Realization that Civil Engineering must now turn to a more deductive approach as a major portion of its research effort in order to solve the problems on our frontiers of the future is now in evidence. Nevetheless, others should give Civil Engineering credit for a proper objective and a legitimate scientific approach in our current courses in spite of the differences in the line of reasoning.

Turning finally to graduate instruction, it is natural that additional study on the frontiers of these same areas should constitute a portion of our advanced program. In order to learn what has gone before there is no alternative to the inductive approach, as the bulk of our literature is expressed in this way.

There is a responsibility on the part of faculties in Civil Engineering to direct future thinking toward deductive reasoning. This is already being done.

Obviously the rate of change depends on the amount of support given research of this nature and the volume of literature published. In any event, if the undergraduate courses in Civil Engineering within the restricted area considered here are engineering science, then the graduate instruction in these disciplines can also be considered as the same.

It is felt that the arguments presented here are a reasonable estimate of the curriculum from the Civil Engineering view. If this be so, Civil Engineering education need not apologize to anyone for lack of effort in the engineering sciences!

A PLEA FOR THE SIMPLE EXPERIMENT

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Have you ever examined an undergraduate engineering laboratory report only to find the major data or results splattered on a graph like the holes of so many shotgun pellets? Have you then looked further, only to be horrified at the detailed "conclusions" drawn from these wild results? If you have, then you are like most of us who teach engineering laboratory courses.

Naturally, we try to keep such travesties on the engineering approach to a minimum. We lecture the student on the principles of sound scientific judgment. We point out that wishful thinking has no place in the analysis of data. We encourage immediate calculation of results in the laboratory itself, rather than afterwards, in the hope that inconsistencies can be uncovered and corrected immediately. We try to guide the student over the more difficult spots without actually doing the work for him.

At any rate, these are some of the approaches constantly used to correct the situation and reduce to a minimum the incidence of "scattergrams" with their attendant confusion. There is, however, at least one other approach which in the opinion of this writer has received too little attention. This is the *simplification* of the experiment and its apparatus.

With simple equipment, far more consistent results are obtainable. Furthermore, the underlying principles—the basic laws or relationships—behind the phenomena being measured become much more apparent to the student. Of course, this means also that the student will perhaps learn less about the actual *operation* of certain equipment. But after all, how much of a loss does this really represent? The student will probably learn more in the way of operating techniques from a few months of industrial experience than he can ever learn in school. In any case, surely the main purpose behind laboratory courses is the same as that behind lecture courses, namely the teaching of fundamentals, not merely of superficial techniques.

Now, admittedly, there are certain advantages to complexity in equipment, provided it is of the proper sort. This plea is not a call for the complete abandonment of industrial-type equipment from laboratory courses. Rather it is a suggestion for the inclusion of *some* simple—very simple—experiments, which will clearly illustrate fundamental principles and give consistent, clear, reproducible results.

Our colleagues in Physics and Chemistry do this. Why not we? The basic principles of heat transfer behind, say, the simple time-temperature curve for the cooling of an ordinary thermometer in air are the same as those behind a complicated heat exchanger, and are more evident—to say nothing of yielding better reproducibility.

This writer has for several years made use of such very simple "two-penny experiments," mainly interspersed between the more complex conventional ones in laboratory courses in chemical engineering unit operations. The policy of using them

has been regularly adopted by the Chemical Engineering Department at the University of Cincinnati.

For these experiments, the student is usually asked to write up his results as a research report for publication in a particular journal, rather than as an industrial report which is our practice for the other, more conventional, experiments. A few simple investigations have also been used as demonstrations directly in engineering lecture classes to illustrate a principle as it is taught.

Just as an example, consider the following little experiment in fluid flow: A glass tube, an inch or so in diameter and one or two feet long, is covered at one end with a piece of thin, loosely woven cloth which is held tightly in place by a rubber band. The tube is mounted vertically with the covered end down, and some fine glass spheres (such as Scotchlite beads supplied by the Minnesota Mining and Manufacturing Company) are poured in to a height of several inches above the cloth.

Next, the tube is filled with water at room temperature and the beads are stirred up a bit with a thin rod to release any entrapped air bubbles. The beads are then allowed to settle back and the water to trickle through.

By timing the fall in liquid level through a short distance, and by measuring the average height of this falling level, we have both a rate and driving force for the general rate equation. Then by varying the head, bed dimensions, particle size, and liquid employed, the quantitative effect of these variables can be readily demonstrated and some of the fundamentals of fluid flow illustrated. The experiment can be extended even further by using non-spherical particles such as sand or heterogeneous beds. Finally, the results can be checked against one or more of the dimensionless correlations in the literature (1,2).

Thus, with only the simplest of apparatus, the fundamental concept of the rate equation, some basic principles in fluid flow, and the utility of correlating variables in terms of dimensionless groups, can all be demonstrated. In addition, the student is given an opportunity to check his results against the literature, which helps him develop confidence both in his own work and in the subject matter under study.

Others of these simple experiments have been published (3, 4). A very interesting compilation with much the same purpose is that of Professor H. Clay Lewis of the Georgia Institute of Technology (5). Actually, such experiments are not too difficult for the instructor, or even the more imaginative students, to devise. In our department we have had considerable success with them. Students find them interesting and, we feel, highly instructive as well.

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A Foreign Professor's

EVALUATION OF ENGINEERING EDUCATION

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Dr. Abou-Taleb is a native of Egypt. He received his undergraduate education in that country on the British System. He then came to the United States, was awarded his Master's degree by the University of Illinois (1949), and his doctoral degree by Stanford University (1952) where he held a teaching assistantship. He has previously taught electrical engineering at the University of Alexandria, Egypt, and at Newark College of Engineering. In 1953 and 1954, Dr. Abou-Taleb visited a number of the institutions in England, France, and other parts of Europe to study their systems of engineering education.

There has been much talk in recent years of how to improve engineering education, but less discussion is devoted to defining clearly what is meant by "good education." To educate engineers effectively, teachers must have a clear concept of their goal, and this concept should differentiate between the requirements in undergraduate and graduate studies.

A good undergraduate education can be defined as one which provides the student with sound technical knowledge and develops in him the following abilities:

a) To express his needs in an intelligent, understandable way.

b) To search the literature for the information he needs and to evaluate it with respect to his problem.

c) To look for and detect the similarities between his problems and those in other fields.

d) To investigate and solve for himself those problems which are

1) sufficiently simple not to warrant a search of the literature,
2) unlike problems that have been discussed in the published literature.

Teaching experience in various universities, both in the United States and abroad, provides a favorable impression of the success with which American schools have provided students with the required technical knowledge. This major objective of good education has been achieved through the use of excellent text-books, through demonstrations in well-equipped laboratories, and through student participation in scientific societies.

On the other hand, American schools appear to fail regrettably in achieving the other major objective, that of developing the abilities enumerated above. A few of the reasons for this are quite clear to professors who have taught in foreign countries where success toward this objective is much higher.

One is the lack of contact between instructors and students. Instructors are always pressed for time, either because their teaching load is heavy, or because their salaries are so low that outside work is necessary to meet their financial needs. Students also have little free time between homework, extra-curricular activities, and often a job which may be supporting a family as well as the student.

In Europe, the professor's income from his regular teaching load is by

no means high, but is quite adequate to provide pleasant living for him and his family. Additional compensation is the high prestige he enjoys in his community. Also, students who show above-average ability in their studies are usually subsidized by the state. This help is usually given in the form of scholarships which generally cover tuition, room and board, and in some cases pocket money. Students also find no disgrace in receiving help from their families.

Another factor which contributes to the failure to develop the American student's abilities is the shortage of competent instructors. A very experienced and capable teacher is required to inject in the student an appreciation of the need for fundamentals. The teacher's basic task is to present the theory behind the method in a way that is comprehensible to the student. Unfortunately, America is producing too few competent teachers who are equal to the challenging job of educating the young. Crowded schools and loss of teachers to industry at an alarming rate make the situation doubly acute.

One more point, which used to be an advantage, but lately has backfired and has become a very serious trend, is the dependence on textbooks and the minimizing of lectures. Some people think it is much better for the student to dig in and get all the information by himself, work out the problems and compare his answers. Letting the student do some reading in the library and getting acquainted with the current literature is certainly an advantage, yet in the undergraduate courses, the student does not have the ability to figure out for himself the easy way to understand the different theorems. Much time and trouble would be saved if instructors introduced the fundamentals and the basic material to the students in advance. These should be introduced in a simple, clear manner that gives students a thorough grasp of the material without the confusion that often results from untutored study of new concepts.

One fact which is also coming into the picture is the rapid advance in technology and science, the increasing pressure of the many different things which the student should know before he leaves school. The curriculum is crowded. There is not enough time to establish the fundamentals before advancing to the applications. Therefore, the student becomes thoroughly confused.

Most of the time he finds that he is very much behind in the assignments and cannot even follow what is going on in the classroom. He decides that he is not good enough for engineering and drops school. Actually he might do all right if the subject were only made a little easier for him.

There is too much emphasis on advanced material, too little on fundamentals. Much more valuable to the student is one basic phenomenon straight in his mind than an acquaintance with several applications of a phenomenon he doesn't understand.

Graduate Level

Actually, the real peril is in graduate study leading to the Master's degree. Increasing numbers of educators are becoming very concerned over the way education toward the Master's degree is conducted. Most of the schools have deviated from real "graduate" education by waiving theses or special studies as requirements for the degree. The Master's degree granted by engineering schools often means only that the student has passed a certain number of courses. When no distinction is made between the requirements of graduate and undergraduate education, why not

grant two undergraduate degrees, or merely extend the undergraduate curriculum to five years?

Achievement of a graduate degree should require a contribution to the field of engineering. Admission to the graduate school should be based on the student's ability and intention to do research that will, in some way, advance the frontiers of engineering knowledge. He definitely needs advanced courses in his field of interest, but these do not replace research.

Students who are interested only in taking specialized courses should not be accepted as degree candidates. The degree represents ability and authority in the area of specialization that the student cannot demonstrate merely by completion of course work. Students who wish to qualify for promotions in their companies by completing courses beyond the undergraduate requirements could be given certificates representing their accomplishments. The advanced degree has a further meaning that is not fullfilled by course work alone.

Evening Education

Evening education has become a means of imposing hardships on the student and his family that are in no way compensated by the knowledge, or the degree, acquired by this means. Urban schools are a deadly bait to the students who want a degree but cannot attend full-time day classes. After a day's work, these wage earners spend three to four hours, four or five evenings every week, attending classes. This goes on for eight or nine years. The hours spent in the classroom rob the student of all leisure for family life, or for study that would increase the pleasure and value of his classes. The procedure by which he obtains his degree defeats the real purpose of education.

JETS TEST ENGINEERING APTITUDE

News from JETS headquarters indicates that 266 clubs were active throughout the country as of December, 1957. Some clubs have as many as 160 members. The JETS have recently initiated a program offering engineering aptitude tests to club members. Tests are administered through the Youth Unlimited Foundation of Eaton Rapids, Michigan, at a cost of $2.00 each. The objective of the program is to scientifically appraise student potentialities.

The Junior Engineering Technical Society was founded to enable students to explore the opportunities and requirements of the engineering and science professions and to help them compare their aptitudes and abilities with these requirements. Headquarters are at East Lansing, Michigan.

CANDID COMMENT

ACCREDITATION OF ENGINEERING SCHOOLS

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The Canons of Ethics for Engineers, Section 24, states, "He will exercise due restraint in criticizing another engineer's work in public, recognizing the fact that the engineering societies and the engineering press provide the proper forum for technical discussions and criticism."

I am dissatisfied with accreditation by ECPD of 153 engineering schools. This dissatisfaction is based on the comparative performance of students from various schools in graduate work and in examination for licenses as professional engineers. A university instructor complained to me of low standards in his department. The head of a university chemical engineering department wrote that the American Institute of Chemical Engineers was doing a better job of accreditation than ECPD.

Those schools just passing the minimum standards are lumped with the best in the country. Yet so far ECPD has not found it feasible to segregate engineering schools into Grades A and B. The engineering student can easily spend $6000–$8000 for his under graduate education only to have it rated as Grade B by the school or university to which he goes for his graduate work. But a Grade B bachelor's degree can increase by perhaps a year the time required to get a master's or doctor's degree at a Grade A engineering school. About 26,300 students in 1955–56 were working for those higher degrees. Even those seeking a bachelor's degree (about 251,100 in the fall of 1956) will be handicapped in the early years of their professional experience by a Grade B education.

Evidence exists that in general the best records in passing examinations for license as a professional engineer are made by graduates from schools in the North and Northeast. This result is probably due in part at least to secondary-school standards which generally are highest in that area. New York probably has the highest standards for professional engineers but such states as New Jersey, Indiana, Michigan, Ohio, Virginia and Florida approximate those standards.

The need for higher educational standards has been seen by ASME. Its Education Committee has been "encouraged to assume aggressive leadership toward improving the standards of education within the field of mechanical engineering in educational institutions." This action would not be necessary if the minimum standards of ECPD were sufficiently high.

Even today our engineering schools are divided into two grades—those accredited and those not accredited. In view of the great need for higher quality engineers, at least three grades are needed, viz.—Grade A, the better accredited schools; Grade B, the poorer accredited schools; and Grade C, the schools not now accredited. One educator admits there is a need for Grades A and B but does not believe they can be put into practice.

Another educator agrees there are a good many who would like to see a listing of Grades A and B but believes that such a listing is practically impossible.

The present list of accredited schools deceives high-school students, their parents and often their counsellors. Many of them think all accredited schools are of equal worth. High-school students are so valuable to the future of engineering that they should be furnished with a list of accredited schools in Grade A only. They are thus put on notice that they will be handicapped by an education elsewhere. They already have this notice as to Grade C schools which are not now accredited.

I propose that the standards of ECPD be raised so that Grade B schools are forced to strive for higher quality as Grade C schools are already doing. Only Grade A schools would be listed as accredited. The current deception of our future engineers as to school grading would be eliminated and all of them would get the benefit by higher educational standards.

HARVEY MUDD TO SURVEY EXPERIMENTAL CURRICULA

Harvey Mudd College, in its first year of operation, has received a grant from the Fund for the Advancement of Education to survey experimental curricula in colleges of science and engineering. Founded in 1955, Harvey Mudd is encouraged, by the philosphy of the school's trustees, to experiment in curriculum and instructional methods. The present grant will enable members of the faculty to visit other colleges where revisions of the science and engineering curricula are under consideration. The content and methods of scientific education in the United States will be explored and the findings made available to the Fund for the Advancement of Education.

SCIENCE EDUCATION SURVEY

Significant aid in the planning of educational programs in science and engineering is expected to result from a nationwide survey now being conducted by the U. S. Office of Education. A tally will be made among juniors in about 1100 colleges and universities to determine the number of students participating in courses in the physical and earth sciences, the biological sciences, mathematics and statistics. The count will provide a basis for estimates of the number of new scientists and mathematicians who will enter the professions with bachelor degrees two years hence, and the number who will obtain doctorates within five years.

. . . . . YET-ITUDES

VIEWS AND NEWS CONTRIBUTED BY

The Young Engineering Teachers

HAROLD A. FOECKE, Chairman
Notre Dame University

ROBERT D. LARUE, Editor
Colorado State University

CURIOSITY AND CREATIVITY

S. B. HAMMOND

Assistant Professor of Electrical Engineering
University of Utah, Salt Lake City

Einstein once said that there is born into the minds of all men an intense curiosity and desire for knowledge, but for most people this is soon educated out of them. The few who fully survive the ordeal of growing up and going to school are those who maintain their God-given desire to be curious about all the things of this universe. From among these few come the intellectual giants and creative thinkers so necessary in an expanding technology. Those who fall by the wayside and lose their inquisitiveness never amount to much; they are left in the frame of mind of the operatic tenor who never found out how the opera ended because he always died in the second act and went home.

Who has not observed a little boy of nine or ten, "so receptive that poets envy him, and so full of searching curiosity that philosophy cannot keep up with his questions." Watch him ten or twelve years later as he leaves college. The intense curiosity which he once felt too often has been channelized and attenuated, robbing him of his lust for true intellectual living. Yet one man with a sincere desire to search out problems and find their answers is worth ten who merely put in their time. To the curious occasionally comes the flash of genius, without which major advances in science are not possible.

A study of the inventions made during the last war showed a relationship between inventiveness and education which was not favorable to our efforts as educators. Generally speaking, the most prolific and imaginative inventors were those with the least education. This indicates that probably something characteristic within the student degenerates as his education progresses. Some facet of his creative ability receives negative development; perhaps other facets do also. Creative ability in engineers is sorely needed. That our education system fails to develop this important trait, and may even hinder its natural advancement, is unfortunate indeed.

Legend tells the story about curiosity killing the cat, and the legend goes on further to show that the cat was very dead. Yet I like to think that the cat died not of curiosity, but of indiscretion. His curiosity to find out whether he actually did have nine lives is commendable; it was his scientific method that was at fault.

Everyone knows that nondestructive tests must be run before the destructive tests when only one sample is available. The cat didn't know this, but he found it out during the

course of his experiment. He was probably the winner in the long run, too, for did he not have the satisfaction of a final glorious experiment, the results of which have been handed down from generation to generation in legend? His experiment is probably understood today by more people than Millikan's oil drop experiment, Faraday's induced voltage experiment, or the Michelson-Morley experiment. Of course he had preconceived notions about the results; he guessed wrong. Yet his experiment was so conclusive that no one has found it necessary to repeat. Today it is partly because of the cat legend that the trait of curiosity is not honored. We have grossly misinterpreted this old story.

Voltaire told the story of the Good Brahmin who wished that he had never been born. He had been studying for forty years, and eventually came to feel that all this time had been lost. "I believe," he said, "that I am composed of matter, but I have never been able to satisfy myself what it is that produces thought. I am even ignorant whether my understanding is a simple faculty like that of walking or digesting, or if I think with my head in the same manner as I take hold of a thing with my hands." The Brahmin's neighbor, an ignorant old woman, was asked if she had ever been unhappy for not understanding how her soul was made. She could not even comprehend the question, for she had never been bothered with such thoughts. She considered herself the happiest of women if she could only get some of the sacred water of the Ganges. Voltaire asked the good Brahmin, "Are you not ashamed to be thus miserable when, not fifty yards from you, there is an old automaton who thinks of nothing and lives contented?" "You are right," he replied. "I have said to myself a thousand times that I should be happy if I were but as ignorant as my old neighbor; and yet it is a happiness which I do not desire."

In this simple story is a remarkable example of intellectual integrity and desire for knowledge and understanding that is rarely seen. For the good Brahmin, ignorance was not bliss. In today's world, knowledge and understanding can lead to a means of survival, whereas ignorance can be certain death. Whitehead has said, "Where attainable knowledge could have changed the issue, ignorance has the guilt of vice." Knowledge and understanding comes best to him who hungers for it; this hunger must be maintained.

Jefferson's words that "all men are created equal" have caused a stalemate in education. Jefferson meant that men are created *politically* equal, and he recognized their physical and intellectual differences. We, too, must recognize the superior intellect, and see to it that he is not educated down to the common level. Otherwise we are blocking our own advance, for a thousand average engineers cannot accomplish what a flash of genius can accomplish, and a thousand unimaginative scientists can only elaborate on the great advances produced by a few intellectual giants whose training did not reduce them to the average. Democracy implies political equality; to claim there is intellectual equality is a farce.

We can all take a lesson from the great teacher Socrates, who tried to make each pupil realize that the truth was in the pupil's own power to attain. He must search long and hard, refute authoritative statements where necessary, and judge his solutions by reason alone. This is the core to creative engineering, and is the most difficult way to teach. But it is the only thing worth teaching in the long run. To encourage individualism and a curious mind is a forgotten ingredient in engineering education. May it return to its rightful prestige.

Teaching Tip—

CORIOLIS ACCELERATION: THE GENERAL CASE

PETER L. BALISE

Associate Professor of Mechanical Engineering
University of Washington, Seattle

In a recent article, Professor Wah * noted that it is increasingly the practice to include Coriolis' Law in sophomore dynamics courses and pointed out the lack of appreciation engendered in students by a purely mathematical derivation. He showed how Coriolis acceleration can be readily seen for a special case. This article extends Professor Wah's discussion by showing how the general case can be easily demonstrated in the classroom.

Teaching can be more effective when students are encouraged to solve a problem for themselves, rather than handed a derivation that is usually ignored except for the final formula. Presentation of the general case of Coriolis acceleration in the manner described below has met with success that illustrates this point.

An important preliminary step is to have the students derive the expression for radial acceleration, $r\omega^2$ or $V\omega$. This derivation emphasizes to them the concept of acceleration for a change in direction of the velocity vector. It is usually followed by the study of mechanisms where relative acceleration is considered only between points on the same rigid body.

Without discussion of Coriolis' Law, the students are then given the problem of determining the acceleration of a block sliding along a straight bar which is rotating about one end (the special case of radial relative velocity). For simplicity, constant angular velocity and constant sliding speed are assumed. It can be observed by students and instructor that the relative acceleration of coincident points on the block and bar seems to be zero, yet common sense indicates that the block should have a different acceleration from the coincident point on the bar. The problem is left in this state for the students to consider.

At the next meeting of the class, some will have seen that there is a tangential acceleration because of change in direction of sliding velocity; others will have noted the increase in tangential velocity as the radius of the coincident point increases; some students may have found both effects. Others of course, will be aware of neither. Class discussion then clarifies this special case, as outlined by Professor Wah.

With this preparation, the general case follows directly. Figure 1 shows a block sliding in a straight groove within a rotating body. The block has a velocity, V_r, relative to the body rotating with angular velocity, ω. The relative velocity is changing direction because the slot is rotating. Thus the block has an acceleration component equal to $V_r\omega$, perpendicular to V_r, just as in the special case of radial relative velocity. The similarity between this acceleration, $V_r\omega$, and ordinary radial

* Thein Wah: "On Coriolis' Acceleration," JOURNAL OF ENGINEERING EDUCATION, Vol. 47, No. 7, March, 1957.

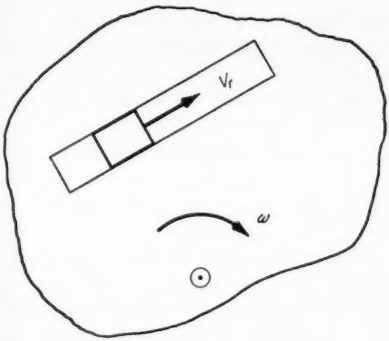

FIG. 1.

acceleration, $V\omega$ or $r\omega^2$, should be noted; both account for change in direction of a velocity vector and are derived in identical manner.

The changing position of the block in the slot causes another acceleration component, which can be seen merely as another part of the change in relative velocity. As shown in Figure 2, first the block is at Q; an instant later it will be at Q', a distance ds away. The velocity of Q' relative to Q is equal to $\omega\ ds$, and is perpendicular to V_r. The velocity component of the block, perpendicular to the slot, must be the same as that of the coincident point on the slot. The velocity of the block will therefore be changed by the velocity of Q' relative to Q (in addition to the other velocity changes).

Since this change in velocity, $\omega\ ds$, takes place in time dt, the corresponding acceleration is $\omega\ ds/dt$, which equals ωV_r. The relative acceleration of the coincident points is therefore equal to $2V_r\omega$, perpendicular to V_r. This value accounts for both change in direction of relative velocity, and the velocity acquired by movement from Q to Q'. Coriolis acceleration is thus viewed as rate of change of relative velocity, rather than as a special mysterious effect.

Following this discussion, the students are challenged by the problem illustrated in Figure 3. This is the special case of a block sliding in a circular slot on a body rotating about the center of curvature of the slot. If V_r is small, the block will revolve clockwise with an angular velocity less than ω, and a radial acceleration less than that of a coincident point on the rotating body. Adding the outward Coriolis acceleration to the inward radial acceleration of the coincident point on the rotating body will give a reduced radial acceleration, just as expected.

If V_r happens to equal $r\omega$, the block will stand still, and its acceleration will be zero. But the Coriolis acceleration is $2V_r\omega$, which equals $2\ r\omega\ \omega$, or $2r\omega^2$, outward. This, added to the acceleration of the coincident point on the slot, which equals $r\omega^2$ inward,

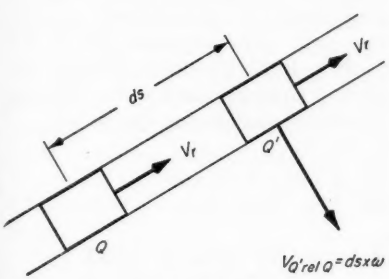

FIG. 2.

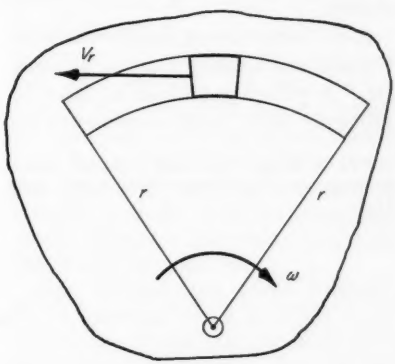

FIG. 3.

seems to give $r\omega^2$ outward, instead of zero! The students are left to find the answer to the puzzle, which of course is that there is an additional inward acceleration, $r\omega^2$, because of the curvature of the slot.

After this has been determined, it can be seen that there might be two other acceleration components in the most general case. One would be the tangential acceleration, $r\ d\omega/dt$, if ω is not constant; the other would be the acceleration, dV_r/dt, in the direction of V_r, if the sliding speed is not constant.

The general case is summarized as follows: The acceleration of any point P moving relative to a coincident point Q is equal to the acceleration of Q plus the acceleration of P relative to Q. The acceleration of P relative to Q consists of the component toward the center of curvature of the relative path if the relative path is curved, the component in the direction of the relative velocity if the relative speed is changing, and the Coriolis component if Q is on a rotating body. The Coriolis component occurs because the direction of the relative velocity vector changes and because point Q' has a velocity relative to point Q; it is equal to $2V_r\omega$ in the direction of the relative velocity change.

A few notes about the literature on Coriolis acceleration may be of interest. A paper published in 1948 by Professor Hall,* with a reference list and discussors' comments, gives an excellent summary of the teaching methods. Most texts, including those published since 1948, either state Coriolis' Law without complete proof, obtain it by differentiation of the displacement equations, use an "equivalent link," or consider the changes in velocity.

Stating the law without proof, or stating the law before proving it, discourages students from thinking about it. Obtaining it by differentiation is mathematically rigorous and, while satisfactory to the professor, leaves many students unconvinced and unconcerned. The "equivalent link" is an interesting method, but it is indirect and therefore may imply that Coriolis acceleration can be understood only by an indirect approach. Some texts consider the changes in velocity only for the special case of radial relative velocity. Others consider the changes for the general case, but the graphics of all the components, when presented together and particularly with the use of an elaborate notation, appear so complex that the average student is repelled.

Students seem to fare better when Coriolis acceleration is obtained by the straight-forward means presented here and is simply added to the other more obvious components of acceleration which the students have previously considered. The use of special rules and such terms as "compound supplementary acceleration" are discouraged. Why not encourage the students to think for themselves by presenting Coriolis acceleration through a series of challenging questions?

* A. S. Hall: "Teaching Coriolis' Law," JOURNAL OF ENGINEERING EDUCATION, June 1948.

MINUTES OF THE MEETINGS OF THE EXECUTIVE BOARD AND GENERAL COUNCIL

October 25 and 26, 1957

In the past it has been customary to print the complete minutes of the governing bodies of the Society, except as an occasional item could not be made public for reasons of expediency. Hoping to present to the membership the salient aspects of the business meetings of the Society's governing agencies in a shorter and more interesting manner, the Executive Board has *VOTED* that the minutes of the meetings of the General Council and Executive Board shall be published in the JOURNAL in digest form. All major items and those involving individual members shall be included in these digests, and complete copies of the minutes shall be available to members from the Office of the Secretary. Accordingly, all votes taken and general agreements on policies or procedures shall be accurately quoted.

Place, Date, and Attendance. The Executive Board and General Council met at the Statler Hotel in New York City on October 25 and 26, in conjunction with the annual meeting of the Engineers' Council for Professional Development on the preceding days. All members of the Executive Board and 43 of the 52 members of the General Council were present.

Lapel Button. The members of the Executive Board were proudly displaying their new ASEE lapel buttons! Anyone desiring the lapel button or a pin should so inform the Secretary and send $3.00 with the order.

YET Paper Contest. The new brochure advertising the YET Paper Contest was distributed; the suggested topics this year center around the activities of the Committee on Development of Engineering Faculties.

Recruiting Practices and Procedures. As a result of requests to reprint for distribution to seniors, copies are being sold at seven cents each for that purpose. Two requests for reprinting in engineering college magazines have been granted.

Report on Evaluation of Engineering Education. The Executive Board *VOTED* that an additional 5,000 copies of the Report on Evaluation of Engineering Education be printed and that the cost be charged to the original fund for the project, which now is termed the "evaluation follow-up" account.

Income and Expenditures for First Quarter. Income looks good compared to last year because dues payments seem to be coming in earlier. Expenditures are difficult to compare because of the differences in actual publication dates of the JOURNAL.

Society Funds. The Executive Board agreed that about $15,000 of Society funds should be reinvested in government bonds bearing about four per cent interest. It was further agreed that the desirable procedure for handling funds for special studies is to retain them in the Treasury of the Society for as long a period as possible, with the Society making regularly scheduled payments to the institution doing the work.

Age Change for Dues Increase. The Executive Board *VOTED* to refer to the Constitution and By-laws Committee the question that the age at which dues change from six to

eight dollars per year be changed from 36 to 30. The present age of 36 was originally considered as a norm for appointment to an associate professor.

Deans of Men. A meeting for deans of men of institutes of technology is being arranged by ECAC for the Annual Meeting at Berkeley. The group is interested in closer affiliation with the Society and this exploratory meeting will determine the real interest and future plans.

Change in Constitution. The proposed change in the Constitution pertaining to succession to the presidency in case of a vacancy was approved by the Executive Committee of ECAC.

Need for Basic Research. The Executive Board agreed with the recommendation of ECAC that the President of the Society and/or others designated by him be prepared to testify as individuals at House and Senate hearings that they "believe more basic research is needed in the engineering sciences."

Cut-backs in Government Research. The recent cut-backs and cancellation of some government research contracts with colleges of engineering resulted in the Chairman of ECRC writing to the Assistant Secretary of Defense (Research and Engineering) discussing the dangers of such practices. The Executive Board *VOTED* that the Secretary of the Society write to Engineers' Joint Council, calling their attention to the 18 October 1957 letter of R. J. Woodrow, and request that they take similar action.

Federal Funds for Research Assistantships. After considerable discussion of a proposed resolution to increase the number of research assistants by means of federal funds, the Executive Board *VOTED* that an *ad hoc* committee of R. A. Morgen, H. E. Wessman, and R. J. Woodrow, Chairman, be appointed to further study the problem and submit a report to the Executive Board as soon as adequate deliberation makes it possible.

Costs of Federal Research Contracts. A new statement of principles for determining costs of federal government contracts has been prepared by ECRC and will be submitted to government officials in November. The statement is based on the inseparability of teaching and research. It was agreed that President Lindvall take whatever action is necessary to achieve the best possible presentation of the statement.

Research Facilities. The field work for the Survey being made by ECRC is complete and about 70 per cent of the data have been analyzed. The federal government is by far the major sponsor of research. The incomplete study also indicates that about nine per cent of the engineering faculties are judged to be capable of conducting research but are not now so involved.

Review of Current Research. ECRC's 1957 edition may be purchased from Dr. Renato Contini of New York University for $2.00 per copy.

Research In Educational Methods. The Executive Board agreed that R. G. Folsom of ECRC and Philip Nudd of the Educational Methods Division confer with A. R. Hellwarth, Chairman of ECAC's Selection and Guidance Committee, to determine what the Educational Testing Service is doing and to then evolve a program if one is deemed desirable.

Technical Institute Division. In a discussion of Division, Section, and Branch activities in the meeting of the Executive Board, the differences between the Technical Institute Division and most others were noted. There was a general belief that all divisions should function in the same

general way and that technical institutes should join the Society on their own merits and not be encompassed only by virtue of the institution's membership based on ECPD accreditation of its college of engineering curricula. The functioning of the Technical Institute Division presented so many unique facets that the Executive Board *VOTED* to refer to the Constitution and By-laws Committee the problem of making a thorough study of the organization, functioning, financing, and the rights and privileges of the Technical Institute Division.

Council Members' Responsibilities. At the conclusion of the reports of the vice presidents at the General Council meeting President Lindvall called attention to the fact that all reports hinted at closer contacts of Sections, Divisions, and Committees with the Executive Board and General Council through the vice presidents. He further added that this desirable closer contact made it imperative that General Council members realize their obligation to transmit information to the groups they represent in a regular and systematic manner. This transmission (and it must be both ways) is essential for smooth and efficient operation of the Society as it is presently organized. The members of the General Council are important links in the system and they should not be negligent of their responsibilities.

Journal of Engineering Education. The dates of issuance now are about the 10th of each month, October through June, with the *Yearbook* being a special February 15 issue.

Brief notes on Section program material will be considered for publication if they are received about two months prior to the date of publication. The flow of papers being submitted for publication is now slightly ahead of capacity to publish. Nevertheless, Sections and Divisions are urged to continue their efforts to submit good papers and to give their recommendations.

Humanistic-Social Summer Institute. Ever since General Education in Engineering was published, attempts have been made by the Humanistic-Social Division to sponsor a Summer Institute. All efforts failed because of a lack of financing. President Lindvall explored the matter with the National Science Foundation and reported that the plans thus far proposed could not be financed by NSF. Some alternate plans were suggested and they will be referred to the Humanistic-Social Division.

Mechanics Examination. Thirty institutions from all over the country are going to participate in a "national examination norm" project. The study developed from the observed fact that the amount and quality of mechanics taught in colleges of engineering varies tremendously and the belief that a unified approach to its teaching was one aspect of an up-grading program.

Civil Engineering Bulletin. Publication is being discontinued because of the lack of an advertiser. In the future the Bulletin may appear in the *Journal,* as the Mechanics Bulletin now does—for the same reason.

Summer Schools for 1958

Educational Methods and CYET. The General Council *VOTED* to approve the joint request of the Educational Methods Division and CYET to sponsor a two-day summer school at Berkeley on the Friday and Saturday of the Annual Meeting week, the general subject being principles of learning in professional education.

Mining Engineering. The General Council *VOTED* to approve a one or two-day summer school on the teaching of mining engineering if the Ex-

ecutive Board of the Mineral Engineering Division approves.

Summer Schools for 1959

Engineering Economy. The General Council *VOTED* to approve a summer school on engineering economy to be held in conjunction with the 1959 Annual Meeting in Pittsburgh, subject to the approval of the host institution.

Humanistic-Social and English. The General Council *VOTED* to approve a summer school jointly sponsored by the Humanistic-Social and English Divisions to be held in conjunction with the 1959 Annual Meeting in Pittsburgh, subject to the approval of the host institution.

Section Affiliation. The General Council *VOTED* that the South Dakota School of Mines and Technology henceforth be in the Rocky Mountain Section. The members at SDSM&T requested the transfer from the North-Midwest Section because they were geographically closer to most of the schools in the Rocky Mountain Section and thus could participate more actively in Section affairs.

Financing of Section Meetings. The Executive Board agreed that since the New England Section finances its meetings by a twenty-dollar contribution from all institutions belonging to ASEE, it would be within the Section's rights and privileges to inform non-member schools regularly having staff members attending in considerable number of the practice and inviting them to make a like contribution if they wished; however, the payment of such a fee is not to be construed as a prerequisite for attendance.

Atomic Energy Education News Letter. Publication on a monthly basis is being resumed as a result of a $2000 contract with the Atomic Energy Commission. If you wish to receive it so inform the Office of the Secretary.

ASEE–AEC Summer Institutes for 1958. Funds are available and indications are that there most probably will be four basic or beginning eight-week programs: four advanced programs on instrumentation and control, metallurgy, chemical processing, and reactor technology; and a basic or beginning course for technical institute instructors.

Society Luncheon at 1958 Nuclear Congress. The Executive Board *VOTED* not to sponsor a Society luncheon in connection with the 1958 Nuclear Congress.

Engineers' Job Directory. Last year's Directory for summer employment of faculty members was developed by Dr. C. E. Work and published in the March, 1957 issue of the *Journal of Engineering Education.* Because of its apparent success a similar program is being developed this year. The Executive Board agreed that the project be referred to the Relations With Industry Division for critical evaluation as a permanent activity of the Society and the submission of a plan of operation if the program be deemed desirable.

Effective Teaching Manual. Several years ago a committee of the Society prepared the manual which was published on a non-profit basis. The publisher states it is now appropriate to decide on a revision or discontinuation to publish. The Executive Board *VOTED* that revision of the Effective Teaching Manual be referred to the Committee on Development of Engineering Faculties for possible adoption as a portion of their program.

Rosters of Graduating Seniors. ECAC reported that the preparation of rosters of graduating seniors and distribution to engineering societies was not judged to be a duty of deans

of engineering; instead, it was expressly believed that such rosters should be prepared by student chapters and that in those cases where no student chapters exist the interested parties should go directly to the departments involved. It is recognized that individual institutions may have previously established unique procedures for handling requests for such rosters.

Appointment of Secretary and Editor. The Executive Board *VOTED* that the annual appointments of the Secretary and Editor be made at the April, or spring, meeting of the Executive Board instead of at its June meeting.

Committee Reports. The General Council agreed that the Secretary of the Society ask for written reports from all Society committees and that those requiring action be brought to the attention of the General Council by the appropriate national officer; chairmen will be invited to be present when their reports are discussed.

Exhibits at Annual Meetings. The General Council *VOTED* that the responsibility for exhibits at Annual Meetings be in the hands of the Local Committees, that the Society establish this general policy, and that any questions arising be referred to the Secretary of the Society.

Future Annual Meetings

1958—University of California at Berkeley, June 16–20
1959—Pittsburgh, June 15–19
1960—Purdue University
1961—University of Kentucky

Next Meetings

Executive Board—April 17 and 18 at Miami Beach, Florida, with the Southeastern Section.
General Council—At the University of California at Berkeley on June 16—dinner meeting with wives, and on June 20—a luncheon meeting for new and old members.

Respectfully submitted,
W. Leighton Collins
Secretary

HARVARD SURVEY CRITICIZES INDUSTRIAL RECRUITING

A team of Harvard researchers has concluded that the growing emphasis on fringe benefits and extras in industrial recruiting practices is downgrading the engineer. Their survey, "Engineering Manpower—How to Improve Its Productivity," can be purchased from Engineering Manpower, P. O. Box 161, Cambridge 38, Massachusetts.

NEW MEMBERS OF ASEE

As of October 31, 1957

AREHART, LEVI E., Instructor in Mechanical Engineering, Wichita University, Wichita, Kan. A. T. Murphy, H. B. Hamilton.

BABEL, HENRY W., Instructor in Industrial Engineering, Ohio State University, Columbus. Albert B. Bishop, Thomas H. Rockwell.

BARNOFF, ROBERT M., Assistant Professor of Civil Engineering, Pennsylvania State University, University Park. B. A. Whisler, R. D. Scheirer.

BAYER, RICHARD, Assistant Professor of Mechanical Engineering, Michigan College of Mining and Technology, Houghton. E. W. Niemi, R. L. Papworth. Divisional interest: Mech. Engnr.

BONANNO, FREDERICK R., Instructor in Mechanics, United States Air Force Academy, Denver, Colo. Archie Higdon, Robert G. Valpey. Divisional interest: Mech. and Matls.; Math.

BRITTON, ROBERT A., Instructor in Engineering Drawing, Missouri School of Mines and Metallurgy, Rolla. L. C. Christianson, C. M. Blevins. Divisional interest: Engnr. Dwg.

BROOKS, HARVEY, Dean of Engineering and Applied Physics, Harvard University, Cambridge 38, Mass. Albert Haertlein, Arthur E. Bryson. Divisional interest: Educ. Admin., Physics.

BURNS, RICHARD L., Instructor in Engineering Drawing and Descriptive Geometry, University of Missouri School of Mines, Rolla. L. C. Christianson, C. M. Blevins. Divisional interest: Engnr. Dwg., Ind. Engnr.

CARIDDI, JAMES G., Instructor in Engineering and Mathematics, Kansas City Missouri Junior College. Allen E. Pollock, James Lawton Bennett. Divisional interest: Engnr. Dwg., Math.

CARNEY, BROTHER J. GEORGE, Chairman, Physics Department, St. Mary's College, Winona, Minn. W. Leighton Collins, F. C. Lindvall. Divisional interest: Physics, Coord. of Coop. Engr.

CORBA, NICHOLAS B., Assistant Professor of Engineering, University of Hawaii, Honolulu 14. Don E. Avery, James B. T. Downs.

DEGLER, HOWARD E., Professor of Mechanical Engineering, University of Wichita, Kan. A. T. Murphy, L. O. Hanson.

DIRASIAN, HENRY A., Instructor in Engineering Drawing, Wayne State University, Detroit 2, Mich. Ralph T. Northrup, Robert W. Grant. Divisional interest: Engnr. Dwg., C. E.

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As of November 12, 1957

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LATVALA, EINO K., Instructor in Mechanical Engineering, Tennessee Arts and Industrial State University, Tullahoma. Joel F. Bailey, Robert L. Young. Divisional interest: Mech. & Mat.; Aeronautics and Aero. Eng.

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GARRETT, CARLOS R., Assistant Professor and Head of Department of Mechanical Engineering, University of Puerto Rico, Mayaguez, Puerto Rico. Wilfredo Hernandez Lopez, F. Gonzalez-Mandry. Divisional interest: M. E.

GOLDSTEIN, STANLEY P., Chairman of Engineering Department, Hofstra College, Hempstead, N. Y. Wesley J. Hennessey, John R. Dunning. Divisional interest: Admin., Educ.; M. E.

GROVES, WALTER A., President, Abadan Institute of Technology, Abadan, Iran. Fred W. Slantz, Lawrence J. Conover. Divisional interest: Admin., Educ.; Gen. Eng.

HAUBOUN, DALE T., Professor of Civil Engineering, University of Pennsylvania, Philadelphia. Lee N. Gulick, Albert Jorgensen. Divisional interest: C. E.

HEYWOOD, HUMPHREY B., Business Manager of The Baylor School, Chattanooga, Tenn. Sam R. Parry, J. G. Wohlford. Divisional interest: Admin., Educ.

HURST, CHARLES J., Instructor in Mechanical Engineering, The Pennsylvania State University, University Park. Jerry G. Richter, Edgar E. Ambrosius. Divisional interest: Mech. Eng.; Mech. and Mat.

HURST, WILLIAM, Assistant Professor of Physics, Southern Technical Institute, Chamblee, Ga. L. V. Johnson, James P. Goodwin, Jr. Divisional interest: Phys.; Shop and Mech. Arts.

IMMING, HARRY S., JR., Assistant Professor of Mechanical Engineering, Rutgers University, New Brunswick, N. J. Ben O. Malmberg, Mark B. Moore. Divisional interest: M. E.

KELLY, BROTHER BERNARD THOMAS, F.S.C., Assistant Professor of Physics, Manhattan College, New York 71. Brother Joseph McCabe, Brother Aubert, F.S.C. Divisional interest: Phys.

KLAUTSCH, ADOLPH A., Senior Technical Instructor, Psychology Section, General Motors Institute, Flint, Mich. W. F. Edington, C. A. Brown. Divisional interest: Human.-Social studies.

KOLLIN, ROBERT, JR., Instructor in Drafting, Henry Ford Community College, Detroit, Mich. William F. Edington, James A. Day. Divisional interest: Eng. Draw.; Shop and Mech. Arts.

LACEY, WM. N., Professor of Chemical Engineering, California Institute of Technology, Pasadena. Wm. H. Corcoran, F. C. Lindvall. Divisional interest: Chem. Eng.

LUBIN, JAMES L., Assistant Professor in Personnel Relations, Newark College of Engineering, Newark, N. J. Leonard Shapiro, Robert Kiehl. Divisional interest: Ind. Eng.; Human.-Social.

MALAKER, STEPHEN F., Professor of Nuclear Engineering, Newark College of Engineering, Newark, N. J. Irving P. Orens, T. A. Schneider.

MARCUVITZ, NATHAN, Professor of Electrical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Ernst Weber, Anthony B. Giordano. Divisional interest: E. E.; Phys.

MIN, TONY CHARLES, Associate Professor of Mechanical Engineering, Alabama Polytechnic Institute, Auburn. Philip J. Potter, J. Gardner Bennett.

MOBLEY, MILTON D., Instructor in Engineering Mechanics, Ohio State University, Columbus. Edgar C. Clark, Samuel B. Folk.

MURPHY, RAYMOND W., Instructor in Mechanical Engineering, Gonzaga University, Spokane 18, Wash. James G. McGivern, W. Leighton Collins.

NAPIER, JAMES J., Assistant Professor of English, Newark College of Engineering, Newark, N. J. James H. Pitman, Warren H. Crater.

PANZECA, PHILIP J., Instructor in Engineering, Hofstra College, Hempstead, N. Y. Wesley J. Hennessy, John R. Dunning. Divisional interest: Ind. Eng.

RICARDO, LOUIS A., Graduate Student Assistant in Mechanical Engineering, University of Pittsburgh, Pittsburgh 13, Pa. William Rudoy, N. Lewis Buck. Divisional interest: M. E.

SCHMIDT, ROBERT, Assistant Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana. Arthur P. Boresi, Charles E. Taylor. Divisional interest: Mech. and Mat.; C. E.

SHAMIS, SIDNEY S., Associate Professor of Electrical Engineering, New York University, New York. Robert F. Cotellessa, Philip Greenstein. Divisional interest: E. E.

STRONGMAN, RUSHTON B., Coordinator of Cooperative Education, Henry Ford Community College, Dearborn, Mich. Henry C. Simons, Arthur W. Angrist. Divisional interest: Coord. of Coop. Engr.; Eng. Draw.

THOMAS, WELCON L., Instructor in Gas Fuel Technology, Southern Technical Institute, Chamblee, Ga. L. V. Johnson, James P. Goodwin, Jr. Divisional interest: Tech. Inst.; Eng.

TORZYN, NOBERT T., Instructor in Electronics, Indiana Technical College, Fort Wayne. Robert C. Ruhl, Ralph S. Carson. Divisional interest: E. E.; Math.

VATER, GERHARD A., Assistant Professor of Electrical Engineering, Vaparaiso University, Valparaiso, Ind. Wm. Shewan, H. C. Hesse. Divisional interest: E. E.; Phys.

WISE, JAMES N., Instructor, Department of English, Newark College of Engineering, Newark, N. J. Warren H. Crater, John T. Shawcross. Divisional interest: Eng.

ZIRNITE, GEORGE P., Instructor in English, Newark College of Engineering, Newark, N. J. James H. Pitman, Warren H. Crater. Divisional interest: Eng.

201 new members
200 previously added

401 new members this year

NEW INSTITUTE FOR BASIC STUDY

The University of Arkansas at Fayetteville has recently announced plans to establish a Graduate Institute of Technology in Little Rock, Arkansas, financed by a state legislative appropriation of $600,000.

Plans for buildings, staff, and curriculum are being developed by an advisory council. The Institute will offer a basic curriculum of advanced scientific and engineering studies with the expectation that future developments will include applied research.

(*Continued from page 350*)

MECHANICAL ENGINEERING. Open September, 1958. To teach machine design and related courses at undergraduate level and assist in development of graduate program in design. M.S. required. Salary open. New facilities with excellent working conditions. Apply to Head of Mechanical Engineering, Colorado State University, Fort Collins.

PHYSICISTS—TWO TEACHING POsitions open; one now, one September, 1958. General physics and some advanced physics courses each quarter. Rank and salary commensurate with qualifications. New faculty housing available. Write to Eivind Horvic, Physics Department, North Dakota State College, Fargo, North Dakota.

UNUSUAL OPPORTUNITY FOR A young Ph.D., in Electrical Engineering Department of an Engineering School with dynamic administration. Exceptional opportunity for very rapid advancement. Apply to Chairman Clifford C. Carr, Electrical Engineering, Pratt Institute, Brooklyn 5, New York.

CIVIL ENGINEERING POSITIONS open. Unusual opportunity for young Ph.D. or Ph.D. candidate in Structures. Graduate Program leading to M.S., opportunities for basic and applied research. Also vacancy for someone in surveying and photogrammetry; applicant should have M.S. and experience. Apply Dr. Earl I. Brown, II, Head, Department of Civil Engineering, Alabama Polytechnic Institute, Auburn, Alabama.

ELECTRICAL AND MECHANICAL Engineering positions open. Teaching assignments are Electric Power, Electronics, Mechanical Vibrations, Fluid Mechanics, and other Mechanical Engineering subjects. Salary depends upon qualifications. Excellent fringe benefits. M.S. in Electrical or Mechanical Engineering desired. Applicants with B.S. considered. Write to Earle M. Morecock, Chairman, Applied Science Division, Rochester Institute of Technology, Rochester, New York.

DEPT. HEAD—INDUSTRIAL ENGIneer with at least a Master's Degree. Nine months basis with possibility of one term of Summer School. Salary open. Location: Southwest. (1)

MECHANICAL ENGINEERING—ASsistant or Associate Professor to teach thermodynamics, vibrations, and mechanical engineering laboratory. M.S. degree required, Ph.D. desirable. Rank and salary commensurate with qualifications. Position available March 17 or September 1, 1958. Write E. R. Stensaas, Head, Department of Mechanical Engineering, South Dakota School of Mines, Rapid City, South Dakota.

MECHANICAL ENGINEERING—openings in thermodynamics, combustion, jet propulsion, nuclear power and the experimental power and design laboratories. Opportunities for developing new courses and research. Salary determined by qualifications. Send resume and summary of interests to Head, Mechanical Engineering, University of Southern California, Los Angeles 7, California.

MASTER'S PROGRAM IN NUCLEAR ENGINEERING

Carnegie Institute of Technology has announced courses leading to the Master's degree in nuclear engineering, to be offered for the first time in September, 1958. The program is cross-departmental, with 75 per cent of the curriculum comprising established courses in mechanical, chemical, or metallurgical engineering, while the remainder presents new courses in nuclear studies.

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